Michigan Department of Transportation
Regional ITS Architectures and Deployment Plans

Grand Region

Final
Regional ITS Architecture

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AD	Archived Data
AHS	Automated Highway System
AMBER	America's Missing: Broadcast Emergency Response
ANSI	American National Standards Institute
APTS	Advanced Public Transportation Systems
ATIS	Advanced Travel Information System
ATMS	Advanced Traffic Management System
AVL	Automated Vehicle Location
CCTV	Closed Circuit Television
CJIC	Criminal Justice Information Center
CRC	County Road Commission
CVISN	Commercial Vehicle Information Systems and Networks
DCM	Data Collection and Monitoring
DMS	Dynamic Message Sign
DNR	Department of Natural Resources
DPW	Department of Public Works
EM	Emergency Management
EMS	Emergency Medical Services
EOC	Emergency Operations Center
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HRI	Highway Rail Intersection
IDAS	ITS Deployment Analysis Software
IEEE	Institute of Electrical and Electronics Engineers
IMMS	Incident Management Message Sets

LIST OF ACRONYMS

ISO	International Standards Organization
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MAC	Medium Access Control
MATS	Muskegon Area Transit System
MAX	Macatawa Area Express
MC	Maintenance and Construction
MDOT	Michigan Department of Transportation
MDT	Mobile Data Terminal
MITSC	Michigan Intelligent Transportation Systems Center
MOU	Memorandum of Understanding
MSP	Michigan State Police
NEMA	National Emergency Management Association
NOAA	National Oceanic and Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
NWS	National Weather Service
RWIS	Roadway Weather Information System
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users
SDO	Standards Development Organization
STMF	Simple Transportation Management Framework
TCP/IP	Transmission Control Protocol/Internet Protocol
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program
TMC	Transportation Management Center
TOC	Traffic Operations Center

LIST OF ACRONYMS

TSC	Transportation Service Centers
UDP/IP	User Datagram Protocol/Internet Protocol
USDOT	United States Department of Transportation
VIVDS	Vehicle Imaging Video Detection Systems
XML	Extensible Mark-up Language

1. INTRODUCTION

1.1 Project Overview

Development of a regional intelligent transportation system (ITS) architecture is one of the most important steps in planning for and implementing ITS in a region. ITS architectures provide a framework for implementing ITS projects, encourage interoperability and resource sharing among agencies, identify applicable standards to apply to projects, and allow for cohesive long-range planning among regional stakeholders. The ITS architecture allows stakeholders to plan for what they want their system to look like in the long-term, and then break out the system into smaller, more modular pieces that can be implemented over time as funding permits.

ITS architectures satisfy the conformity requirements first established in the Transportation Equity Act for the 21st Century (TEA-21) highway bill and continued in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) bill passed in 2005. In response to Section 5206(e) of TEA-21, the Federal Highway Administration (FHWA) issued a final rule and the Federal Transit Administration (FTA) issued a final policy that required regions implementing any ITS projects using federal funds to have an ITS architecture in place by April 2005. After this date, any ITS projects must show conformance with their regional ITS architecture in order to be eligible for funding from FHWA or FTA. Regions that had not yet deployed ITS were given four years to develop an ITS architecture after their first ITS project proceeded to final design.

In November 2006, the Michigan Department of Transportation (MDOT) began development of the Grand Regional ITS Architecture. The Regional ITS Architecture has the same geographic boundaries of the MDOT Grand Region Metropolitan Area, but excludes the Grand Rapids municipal area, which completed a Strategic Deployment Plan and Regional Architecture in February 2006. The Grand Regional ITS Architecture references the *Grand Rapids Metropolitan Area ITS Strategic Deployment Plan* (HNTB and Iteris, February 2006) and the *Grand Region ITS Architecture* completed in 2002. Key portions of this document will show how the Grand Region will integrate with the Grand Rapids Metropolitan Area. The Regional Architecture focuses on a 10-year vision of ITS for the Grand Region and dovetails with the existing Grand Rapids Metropolitan Area Regional ITS Architecture. In addition, a separate ITS Deployment Plan was developed to identify and prioritize specific ITS projects recommended for the Region in order to implement the ITS architecture. The ITS Deployment Analysis Software (IDAS) was utilized to evaluate and prioritize the list of ITS projects outlined for the Grand Region.

The ITS Architecture and the ITS Deployment Plan were both developed with significant input from local, state, and federal officials. A series of four workshops were held to solicit input from stakeholders and ensure that the plans reflected the unique needs of the Region. Copies of the draft reports were provided to all stakeholders. The Regional ITS Architecture and Deployment Plan developed reflects an accurate snapshot of existing ITS deployments and future ITS plans in the Region. Needs and priorities of the Region will change over time and in order to remain effective this plan should be periodically reviewed and updated.

1.2 Document Overview

The Grand Regional ITS Architecture report is organized into five key sections:

Section 1 – Introduction

This section provides an overview of the National ITS Architecture requirements, the Grand Regional ITS Architecture, and the key features and stakeholders in the Grand Region.

Section 2 – Regional ITS Architecture Development Process

An overview of the key steps involved in developing the ITS Architecture for the Grand Region is provided in this section. It includes a discussion of stakeholder involvement, architecture workshops, and the architecture development process.

Section 3 – Customization of the National ITS Architecture for the Grand Region

This section contains a summary of regional needs and details the customization of the National ITS Architecture to meet the ITS vision for the Grand Region. The market packages that were selected for the Region are included in this section and interconnects are presented, including the "sausage diagram" showing the relationships of the key subsystems and elements in the Region.

Section 4 – Application of the Regional ITS Architecture

Functional requirements and standards that apply to the Region, as indicated by the Regional ITS Architecture, are presented in Section 4. Operational concepts identifying stakeholder roles and responsibilities have been prepared and potential agreements to support the sharing of data and resources have been identified.

Section 5 – Maintaining the Regional ITS Architecture

A use and maintenance plan has been developed for the Grand Regional ITS Architecture and is included in this section. The plan outlines the procedure for updating the ITS architecture over time.

The Grand Regional ITS Architecture also contains five appendices:

- Appendix A – National ITS Architecture Market Package Definitions;
- Appendix B – Customized Market Packages;
- Appendix C – Element Functional Requirements;
- Appendix D – Stakeholder Database; and
- Appendix E – Architecture Conformance and Maintenance Documentation Form.

1.3 Assessment

The Grand Regional ITS Architecture and Deployment Plan has been assessed based on twelve items derived from both the April 8, 2001 USDOT ITS Architecture and Standards Conformity Rule/Policy and from the architecture development process described in the *Regional ITS Architecture Guidance Document*. A listing of these items is shown in **Table 1**.

Table 1 - Summary of Architecture Assessment Categories

Content Criteria	Architecture Implementation Criteria
1. Architecture Scope	8. Implementation Plan (use)
2. Stakeholder Identification	9. Maintenance Plan
3. System Inventory	10. Agreements
4. Needs and Services	11. Standards Identification
5. Operational Concept	12. Project Sequencing
6. Functional Requirements	
7. Interfaces/Flows	

1.4 The Grand Region

1.4.1 Geographic Overview

The Grand Region is defined by the boundary of Lake Michigan to the west, the MDOT North Region to the north, the MDOT Bay Region to the east, and the MDOT Southwest Region to the south, as shown in **Figure 1**. The Region encompasses 7 of the 8 counties of the MDOT Grand Region of Michigan. The region excludes the Grand Rapids Metropolitan Area, which is comprised of Kent County and portions of Ottawa County.

Since the Grand Rapids Metropolitan Area is excluded from this architecture development, the largest cities within the geographical boundaries of the Grand Region include Muskegon, Grand Haven, and Holland. When developing the stakeholder group, the project team coordinated with MDOT to invite the appropriate townships, cities, counties, state and federal agencies, and area transit providers. The Muskegon Area Transit System (MATS), Macatawa Area Express (MAX), and Ionia Transit Authority are the primary transit providers that operate within the regional boundaries. The Muskegon Area Transit System provides fixed route and paratransit service within Muskegon County. The Macatawa Area Express operates fixed route and paratransit coverage for the City of Holland, Holland Charter Township, and the City of Zeeland. The Ionia Transit Authority provides demand-response and advance reservation service to the City of Ionia and the townships of Berlin, Easton, and Ionia. **Table 2** in Section 1.3.4 identifies the stakeholders that participated in the process.

When developing the architecture, a 20-year vision for ITS in the Region was documented. In the ITS Deployment Plan, the 20-year time frame was broken down into smaller time periods to prioritize and sequence the projects. The naming convention used for elements in the Grand Regional ITS Architecture is consistent with the naming convention that is used in the North, Bay, Superior, and Southwest Regions and the Statewide ITS Architecture. Naming conventions inconsistent with the existing Grand Rapids Metropolitan Area Regional ITS Architecture are also clarified within this architecture. This consistency provides seamless connections to those other architectures without requiring that they be specifically called out. Statewide initiatives - such as statewide commercial vehicle operations and 511 traveler information service - are referenced in the regional ITS architecture, but will be addressed in further detail in the Statewide ITS Architecture.

1.4.2 Transportation Infrastructure

As illustrated in **Figure 1**, the Region is connected by several State and Federal highways. The primary roadway facilities in the study area include US 131, US 31, I-96, I-196, and M 46.

US 131 is one of the major north-south roadways that connects Grand Rapids with Kalamazoo in the Southwest Region and Cadillac in the North Region. M 46 runs concurrently with US 131 for a short span, but primarily runs east-west beginning in the Muskegon area and traversing east across the Region towards Saginaw in the Bay Region. US 31 is a major north-south route that runs along the Lake Michigan coast connecting the Holland – Macatawa area with the Muskegon area. I-96 runs east-west across the southern edge of the region connecting traffic traveling westbound from Lansing to the Muskegon area. I-196 breaks off of I-96 in Grand Rapids and runs southwest to the Holland – Macatawa area on Lake Michigan.

Figure 1 - Grand Regional Boundaries

1.4.3 Grand Region ITS Plans

The Grand Region began the development of a Regional ITS Architecture in 2006 when MDOT contracted with a consultant to develop several regional ITS architectures and deployment plans in the State of Michigan. Version 5.1 of the National ITS Architecture was used in the Architecture development.

It is important to recognize the initial deployment of ITS infrastructure in a region because as of April 2005, in order for a region to be eligible for funding for ITS projects from the Highway Trust Fund the United States Department of Transportation (USDOT) requires that the region have an ITS architecture developed. This requirement only applies to regions with existing ITS infrastructure deployed. For regions that do not have any ITS infrastructure deployed, the USDOT requires that they have an ITS architecture within four years of their first ITS project entering final design.

The Grand Region excludes the Grand Rapids Metropolitan Area from the Regional Boundaries since this region already has an ITS Regional Architecture completed in 2002 and a Strategic Deployment Plan updated in February 2006. The Grand Rapids Metropolitan Area consists of several significant deployments, but those ITS components are also excluded from this architecture. The Grand Region has several ITS components deployed outside of the Grand Rapids Metropolitan area. Examples of implementations in the Region include closed loop signal systems, portable dynamic message signs (DMS), and weigh-in-motion sensors. As the Grand Region pursues funding opportunities for proposed projects, it will be necessary to show that a project fits within the ITS architecture developed for the Region.

1.4.4 Stakeholders

Due to the fact that ITS often transcends traditional transportation infrastructure, it is important to involve non-traditional stakeholders in the architecture development and visioning process. Input from these stakeholders, both public and private, is a critical part of defining the interfaces, integration needs, and overall vision for ITS in a region.

Table 2 contains a listing of stakeholders in the Grand Region who have participated in the project workshops or provided input to the study team as to the needs and issues that should be considered as part of the Regional ITS Architecture. Other stakeholders that were invited to participate but were not able to attend were provided minutes of workshops and copies of reports to encourage their participation as much as possible. **Appendix D** contains a copy of the stakeholder database and workshop attendance records.

Table 2 - Grand Stakeholder Agencies and Contacts

Stakeholder Agency	Address	Contact
City of Belding, Dial-A-Ride	100 Depot Street Belding, Michigan 48809	Suzanne Christensen
City of Big Rapids Public Works	226 North Michigan Avenue Big Rapids, Michigan 49307	Tim Vogel
City of Grand Haven, Harbor Transit	519 Washington Avenue Grand Haven, Michigan 49417	Julie Bildner
City of Newaygo	28 State Road Newaygo, Michigan 49337	Ron Wight
FHWA - HDA-MT	400 Seventh Street, SW Washington DC 20590	Tim Crothers

Table 2 - Grand Stakeholder Agencies and Contacts

Stakeholder Agency	Address	Contact
FHWA - Michigan	315 West Allegan, Suite 201 Lansing, Michigan 48933	Morrie Hoevel
Grand Haven Public Safety	525 Washington Avenue Grand Haven, Michigan 49471	Mark Reiss
Grand Haven Streets & Utilities	519 Washington Avenue Grand Haven, Michigan 49471	William Hunter
Macatawa Area Coordinating Council	400 136th Avenue, Suite 416 Holland, Michigan 49424	Steve Bulthuis
MDOT	425 West Ottawa Street Mail Code B235 Lansing, Michigan 48933	Mike Walimaki
MDOT - Grand Rapids TSC	2660 Leonard Street, NE Grand Rapids, Michigan 49525	Paul Arends
MDOT - Grand Region	1420 Front Avenue, N.W. Grand Rapids, Michigan 49504	Joseph Finch
MDOT - Grand Region	1420 Front Avenue, N.W. Grand Rapids, Michigan 49504	Suzette Peplinski
MDOT - Grand Region	1420 Front Avenue, N.W. Grand Rapids, Michigan 49504	Steven Redmond
MDOT - Howard City TSC	19153 West Howard City-Edmore Road Howard City, Michigan 49329	Karl Koivisto
MDOT - Howard City TSC	19153 West Howard City-Edmore Road Howard City, Michigan 49329	Sarah Huffman
MDOT - ITS Program Office	18101 West Nine Mile Road Southfield, Michigan 48075	Collin Castle
MDOT - ITS Program Office	425 West Ottawa Street Mail Code B235 Lansing, Michigan 48933	Greg Krueger
MDOT - Muskegon TSC	2225 Olthoff Drive Muskegon, Michigan 49444	David Brinks
MDOT - Muskegon TSC	2225 Olthoff Drive Muskegon, Michigan 49444	Tim Judge
MDOT - Southwest Region	1501 Kilgore Road Kalamazoo, Michigan 49001	David VanStensel
Mecosta County Road Commission	120 North DeKraft Avenue Big Rapids, Michigan 49307	Nick Petersen
MSP - 6th District	588 Three Mile Road Grand Rapids, Michigan 49544	Doug Roesler
MSP - 6th District Motor Carrier Division	588 Three Mile Road Grand Rapids, Michigan 49544	Alfred Newell
Muskegon Area Transit System	2624 Sixth Street Muskegon Heights, Michigan 49444	James Koens
Ottawa County Road Commission	PO Box 739 Ottawa, Michigan 49417	Jerry Diekema
Ottawa County Road Commission	PO Box 739 Ottawa, Michigan 49417	Fred Keena

Table 2 - Grand Stakeholder Agencies and Contacts

Stakeholder Agency	Address	Contact
Total Traffic Network	77 Monroe Center, Suite 1000 Grand Rapids, Michigan 49505	Robb Westaby
URS	3950 Sparks Drive, SE Grand Rapids, Michigan 49546	Marcus Byker
URS	3950 Sparks Drive, SE Grand Rapids, Michigan 49546	Marc Start

2. REGIONAL ITS ARCHITECTURE DEVELOPMENT PROCESS

Development of the Regional ITS Architecture and Deployment Plan for the Grand Region relied heavily on stakeholder input to ensure that the architecture reflected local needs. A series of four workshops was held with stakeholders to gather input, and draft documents were made available to stakeholders for review and comment.

The process followed for the Grand Region was designed to ensure that stakeholders could provide input and review for the development of the Region's ITS Architecture and Deployment Plan. **Figure 2** illustrates the process followed.

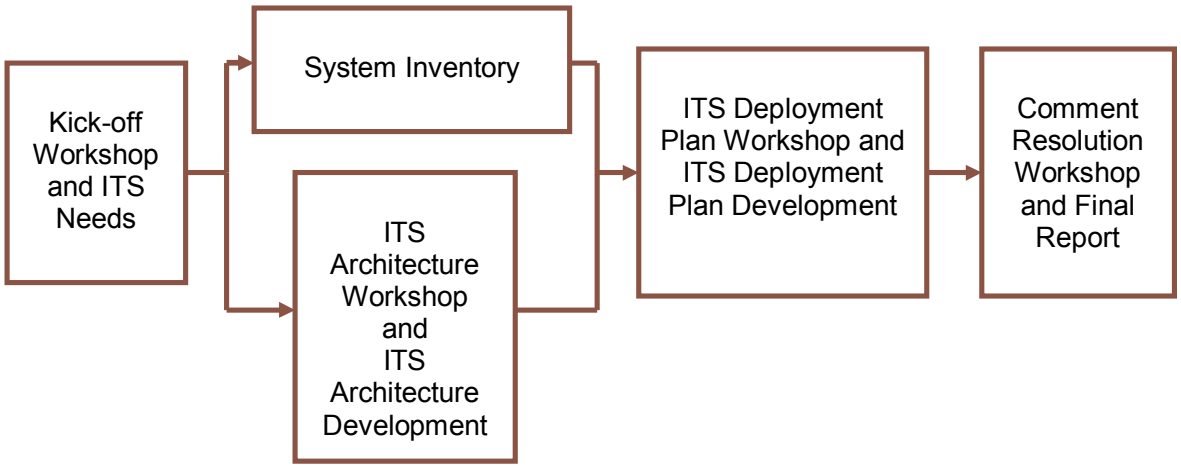

Figure 2 - Grand Regional ITS Architecture and Deployment Plan Development Process

A total of four workshops with stakeholders over a period of eleven months were used to develop the Grand Regional ITS Architecture and Deployment Plan. These workshops included:

- Kick-Off Workshop, December 5, 2006;
- Regional ITS Architecture Development Workshop, January 17, 2007;
- ITS Deployment Plan Workshop, August 2, 2007; and
- Comment Resolution Workshop, December 4, 2007.

Key components of the process are described below:

Task 1 – Kick-Off Workshop and ITS Needs: A stakeholder group was identified that included representatives from regional transportation, transit, and emergency management/public safety agencies. The group was invited to the project Kick-Off Workshop where ITS needs for the Region were identified.

Task 2 – System Inventory: Collecting information for the system inventory began at the Kick-Off Workshop through discussions with the stakeholders to determine existing and planned ITS elements in the Region. After the Kick-Off Workshop, follow-up calls were conducted with several local stakeholders to gather additional input.

Task 3 – ITS Architecture Workshop and ITS Architecture Development: The purpose of the Regional ITS Architecture Workshop was to review the system inventory with stakeholders and develop the Grand Regional ITS Architecture. Training on the National ITS Architecture was integrated into the

workshop so that key elements of the architecture, such as market packages, could be explained prior to the selection and editing of these elements. The result of the Regional ITS Architecture Workshop was an ITS Architecture for the Grand Region that included a system inventory, interconnect diagram, customized market packages, and relevant ITS standards. Following the workshop, a Revised Draft Regional ITS Architecture document was prepared and sent to stakeholders for review and comment.

Task 4 – ITS Deployment Plan Workshop and ITS Deployment Plan Development: A draft project listing for the Region was presented to stakeholders at the Regional ITS Deployment Plan Workshop. Stakeholders were asked to provide input on the recommended projects, responsible agencies, associated costs, and deployment timeframe. Following the workshop, a Draft Regional ITS Deployment Plan document was prepared and sent to stakeholders for review and comment.

Task 5 – Comment Resolution Workshop and Final Report: A Comment Resolution Workshop was held with stakeholders to review the Draft Regional ITS Architecture and the Draft Regional ITS Deployment Plan. Next steps for the Region were also discussed. Comments were incorporated and a final Regional ITS Architecture and Regional ITS Deployment Plan were developed.

3. CUSTOMIZATION OF THE NATIONAL ITS ARCHITECTURE FOR THE GRAND REGION

Coordination with the existing Grand Rapids Metropolitan Area Strategic Deployment Plan and ITS Regional Architecture warrants that stakeholders and stakeholder agencies included in both architectures be clearly identified. There were five agencies identified in the Grand Rapids Metropolitan Area Architecture that were also included in the Grand Region ITS Regional Architecture. These stakeholders and their corresponding names are listed in **Table 3**.

Table 3 - Comparison of Stakeholder Names with Existing Architecture

Grand Regional ITS Architecture	Grand Rapids Metropolitan Area Strategic Deployment Plan
West Michigan TMC	Grand Rapids Metro ITS Operations Center
MDOT Grand Region Office	MDOT Grand Region Office
MSP District 6 Dispatch – Rockford	Michigan State Police Post
Local Agency	Ottawa County Road Commission
Local Agency	Ottawa County 911 Dispatch

Since the existing Grand Rapids Plan is being utilized for several deployments, it was not updated as part of this project. As ITS grows in the Grand Region, both plans will warrant updates and continued maintenance. It is recommended that the next update of the Grand Rapids Metropolitan Area include all of the Grand Region and merge these two documents. It also is recommended that a single architecture database and a single deployment plan be created at the time of the update.

3.1 Systems Inventory

An important initial step in the architecture development process is to establish an inventory of existing ITS elements. At the Kick-Off Workshop and through subsequent discussions with agency representatives, Grand Region stakeholders provided the team with information about existing and planned systems that would play a role in the Region's ITS architecture.

The National ITS Architecture has eight groups of ITS service areas. Existing, planned, and future systems in the Region were identified in the following service areas:

- ***Traffic Management*** – includes the West Michigan Transportation Management Center located in Grand Rapids as well as other existing and future TMCs and traffic operations centers (TOCs), detection systems, closed circuit television (CCTV) cameras, fixed and portable dynamic message signs, and other related technologies.
- ***Emergency Management*** – includes emergency operations/management centers, improved information sharing among traffic and emergency services, automated vehicle location (AVL) on emergency vehicles, traffic signal preemption for emergency vehicles, and wide-area alerts.
- ***Maintenance and Construction Management*** – includes work zone management, roadway maintenance and construction information, winter maintenance, and road weather detection systems.
- ***Public Transportation Management*** – includes transit and paratransit AVL, dispatch systems, transit travel information systems, electronic fare collection, and transit security.

- ***Commercial Vehicle Operations*** – includes coordination with Commercial Vehicle Information Systems and Networks (CVISN) efforts, and hazardous material (HAZMAT) management.
- ***Traveler Information*** – includes broadcast traveler information such as 511, traveler information kiosks, and highway advisory radio (HAR).
- ***Archived Data Management*** – includes electronic data management and archiving systems.
- ***Vehicle Safety*** – includes collision avoidance and automated highway systems.

3.2 Regional Needs

Needs from the Region were identified by Stakeholders at the Kick-Off Workshop held in December of 2006. The needs identified provided guidance for determining which market packages should be included in the architecture. Stakeholders identified ITS needs for the Grand Region in the following areas:

- Traffic management;
- Emergency management;
- Maintenance and construction management;
- Public transportation management;
- Commercial vehicle operations;
- Traveler information; and
- Archived data management.

Section 3.4.3 contains additional information about the specific needs identified and relates those needs to the market packages that document the corresponding ITS service.

3.3 Element Customization

The inventory and needs documented at the Kick-Off Workshop are the starting point for developing an ITS architecture for the Grand Region. These ITS systems and components are used to customize the National ITS Architecture and create the Architecture for the Grand Region.

When developing customized elements, the stakeholder group agreed not to create individual traffic, maintenance, and emergency management elements for individual cities within the Grand Region. The smaller communities in the Region were documented as part of the local agency elements. This documentation allows the communities to be included in the Regional ITS Architecture, and therefore eligible to use federal monies on potential future ITS deployments.

3.3.1 Subsystems and Terminators

Each identified system or component in the Grand Region ITS inventory was mapped to a subsystem or terminator in the National ITS Architecture. Subsystems and terminators are the entities that represent systems in ITS.

Subsystems are the highest level building blocks of the physical architecture, and the National ITS Architecture groups them into four major classes: Centers, Field, Vehicles, and Travelers. Each of these major classes includes various components that represent a set of transportation functions (or processes). Each set of functions is grouped under one agency, jurisdiction, or location, and correspond to physical elements such as: traffic operations centers, traffic signals, or vehicles. **Figure 3** shows the National ITS Architecture subsystems. This figure, also known as the "sausage diagram," is a standard interconnect diagram, showing the relationships of the various subsystems within the

architecture. A customized interconnect diagram for the Grand Region is shown in **Figure** . Communication functions between the subsystems are represented in the ovals. Fixed-point to fixed-point communications include not only twisted pair and fiber optic technologies, but also wireless technologies such as microwave and spread spectrum.

Terminators are the people, systems, other facilities, and environmental conditions outside of ITS that need to communicate or interface with ITS subsystems. Terminators help define the boundaries of the National ITS Architecture as well as a regional system. Examples of terminators include: drivers, weather information providers, and information service providers.

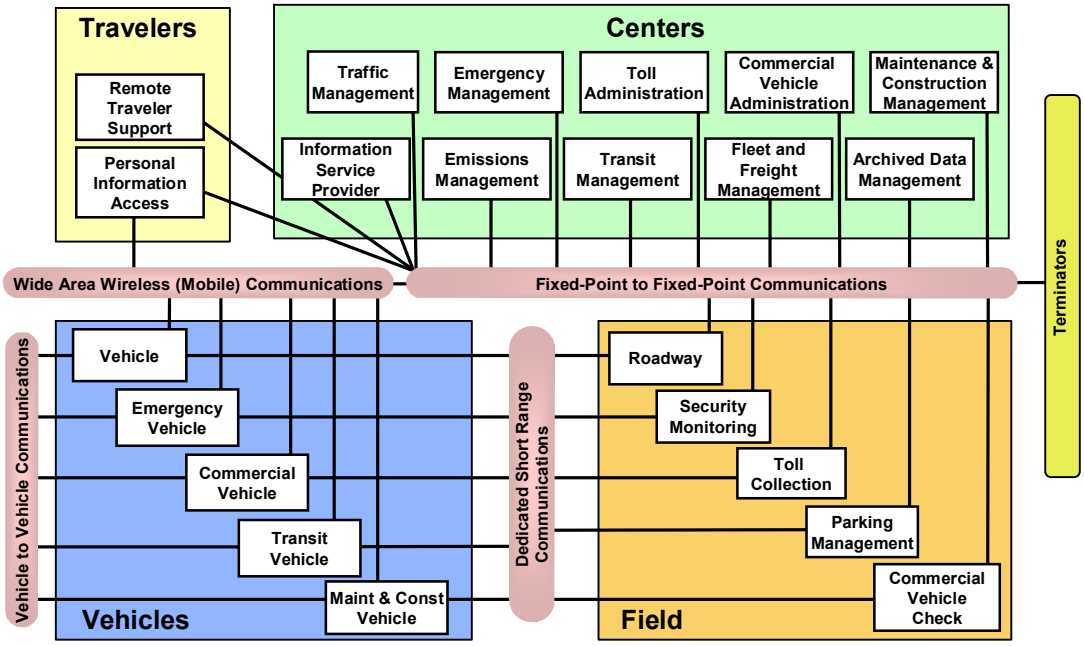

Figure 3 - National ITS Architecture Physical Subsystem Interconnect Diagram

3.3.2 ITS Inventory by Stakeholder

Each stakeholder is associated with one or more systems or elements (subsystems and terminators) that make up the transportation system in the Grand Region. A listing of stakeholders as identified in the Architecture can be found in **Table 4** along with a description of the stakeholder. For example, rather than individually documenting each of the smaller local agencies in the Region, a single stakeholder was created for local agencies which represents the cities and towns not specifically called out in the architecture. **Table 5** sorts the inventory by stakeholder so that each stakeholder can easily identify and review all of the architecture elements associated with their agency. The table includes the status of the element. In many cases, an element classified as existing might still need to be enhanced to attain the service level desired by the Region.

Table 4 - Grand Region Stakeholder Descriptions

Stakeholder	Stakeholder Description
Department of Homeland Security	The Department of Homeland Security is responsible for coordinating with multiple agencies to secure the nation's borders and protect the infrastructure and citizens.
DNR	Michigan Department of Natural Resources is responsible for the operations and maintenance of all Parks and Recreation facilities including infrastructure components on those properties. DNR utilizes some technologies to provide information to visitors at Parks and Recreation facilities.
Financial Institution	Financial Institutions involved in the transfer of funds for fare collection as well as for other fee based transportation services. Can handle the exchange of money for transit electronic fare collection or toll collection.
Ionia Transit Authority	Transit provider that operates paratransit service within Ionia County.
Local Agency	Local government includes municipalities, counties, and townships and covers all departments within those agencies that deal with traffic, public safety, emergency management, public works and school transportation agencies. Local Agencies include: City of Holland, Ottawa CRC, City of Greenville, City of Ionia, City of Muskegon, Muskegon CRC, City of Norton Shores, City of Muskegon Heights, City of Zeeland, City of Portland, Chippewa Hills and Mecosta CRC.
MAX	Macatawa Area Express (MAX) is the transit authority for the Greater Holland area; it operates fixed route and demand responsive routes.
MDOT	The Michigan Department of Transportation is responsible for the planning, design, construction, maintenance and operation for all aspects of a comprehensive integrated transportation system in the State of Michigan. Some of these roles are achieved through contract services with local agencies and private entities.
Media	Local media outlets. This can include television stations, newspapers, radio stations and their associated websites.
MSP	Michigan State Police is the state law enforcement agency that enforces traffic safety laws as well as commercial vehicle regulations.
Muskegon Area Transit System	Transit provider that operates both fixed route and paratransit service within Muskegon County.
NOAA	National Oceanic and Atmospheric Administration gathers weather information and issues severe weather warnings.
Other Agencies	This stakeholder represents a wide variety of agencies. The associated elements are groups of agencies or providers that do not have a primary stakeholder agency.
Other Elements	Other elements include potential obstacles, roadway environment and other vehicles
Private Information Service Provider	Private sector business responsible for the gathering and distribution of traveler information. This service is typically provided on a subscription basis.
Private Operators	Private Operators manage privately owned resources that interconnect with public sector elements and sub-systems of the Regional Architecture.
Private Transportation Providers	Private transportation service providers such as taxis and shuttle services.
Rail Operators	Companies that operate trains and/or are responsible for the maintenance and operations of railroad tracks.
Regional Demand Response Transit Providers	Transit providers in the Grand region aside from Ionia Transit Authority, Muskegon Area Transit System and Macatawa Area Express that operate paratransit service in the region. The agencies include Big Rapids, Belding and Grand Haven (Harbor Transit)
System Users	All of the users of the transportation system.

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Department of Homeland Security	Department of Homeland Security	Responsible for coordinating with multiple agencies to secure the nation's borders and protect the infrastructure and citizens.	Existing
DNR	DNR Weather Stations	Department of Natural Resources field equipment that collects weather data such as temperature and visibility.	Existing
Financial Institution	Financial Service Provider	Handles exchange of money for transit electronic payment collection.	Existing
	Service Agency	Agency responsible for payment of transit fares for medical transportation as part of government subsidized medical care. This includes Medicare, and VA programs.	Existing
Ionia Transit Authority	Ionia Transit Authority Data Archive	The transit data archive for the Ionia Transit Authority. Used by FTA and MDOT Office of Public Transportation.	Planned
	Ionia Transit Authority Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of demand response vehicles operated by Ionia Area Transit Authority.	Planned
	Ionia Transit Authority Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	Ionia Transit Authority Transit Center CCTV Surveillance	CCTV surveillance at the Ionia Transit Authority Transit Center.	Planned
	Ionia Transit Authority Vehicles	Transit Vehicles owned by Ionia Area Transit Authority.	Existing
	Ionia Transit Authority Website	Website with information about fares and schedules. At this time the website is static.	Planned
Local Agency	County 911 Dispatch	Central Dispatch is responsible for the dispatch of all public safety vehicles (police and fire). After hours Central Dispatch will also dispatch the Street Department on-call emergency responder. Counties included are Muskegon, Newaygo, Montcalm, Ottawa and Ionia.	Existing
	County Road Commission	Contract agency managed by a county that oversees road maintenance and snow removal on local and MDOT facilities.	Existing
	County Road Commission Vehicles	County Road Commission vehicles used in maintenance operations.	Existing

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Local Agency (continued)	Gerald R Ford International Airport	Airport located in Grand Rapids, Michigan. The Kent County Department of Aeronautics is responsible for the management and operation of the airfield and airport facilities.	Planned
	Ionia County Airport	Airport owned by Ionia County serving mostly single engine airplanes.	Planned
	Local Agency Anti-Icing Field Equipment	Roadside equipment located along routes maintained by local agencies that collects weather data such as temperature and visibility.	Planned
	Local Agency CCTV	Roadside equipment on local routes used for traffic condition monitoring and management of incidents.	Existing
	Local Agency DPW	Contract agency managed by a local municipality that oversees road maintenance and snow removal on local and MDOT facilities.	Existing
	Local Agency DPW Vehicles	Local Government vehicles used in maintenance operations.	Existing
	Local Agency ESS	Environmental sensor stations operated by local agencies that collect information about the roadways such as temperature and moisture levels.	Planned
	Local Agency Field Sensors	Roadway equipment on local routes used to detect vehicle volumes and/or speeds. This information is used in the operation of the traffic signal system and collected by the TOC.	Planned
	Local Agency Fog Detection	Roadside equipment operated by local agencies that collect information about fog visibility levels in fog prone areas.	Planned
	Local Agency High Water Detection	Roadside equipment operated by local agencies that collect information about the water level on flood prone roadways.	Planned
	Local Agency Parking Management System	System operated by a local agency that monitors available vehicle parking at key parking facilities.	Planned
	Local Agency Public Safety Vehicles	Local law enforcement, fire and EMS vehicles. Includes the ITS equipment installed on the cruisers (AVL, MDTs, etc.).	Existing
	Local Agency Ridesharing Program	System used for matching riders with similar origins and destinations to promote carpooling.	Planned
	Local Agency Roadway Barrier System	Roadside equipment operated by local agencies that close roadway segments automatically due to unsafe conditions such as flooding.	Planned

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Local Agency (continued)	Local Agency TOC	Local Traffic Operations Center responsible for municipal signal system operations.	Planned
	Local Agency Traffic Signals	Multiple traffic signals interconnected and operated by a Local Agency.	Existing
	Local Agency Website	Website for the Local Agencies.	Existing
	Local Emergency Operations Center	Central command and control facility responsible for carrying out the principles of emergency preparedness and emergency management, or disaster management functions at a strategic level in an emergency situation.	Planned
	Mason/Oceana 911	911 Dispatch for Mason and Oceana Counties. Central Dispatch is responsible for the dispatch of all Mason and Oceana County public safety vehicles (police and fire). After hours Central Dispatch will also dispatch the Street Department on-call emergency responder.	Existing
	Mecosta/Osceola Central Dispatch	911 Dispatch for Mecosta and Osceola Counties. Central Dispatch is responsible for the dispatch of all Mecosta and Osceola County public safety vehicles (police and fire). After hours Central Dispatch will also dispatch the Street Department on-call emergency responder.	Existing
	Roben - Hood Airport	Owned and operated by the City of Big Rapids.	Planned
	School Transportation Agencies	Agencies responsible for operating school bus fleets.	Existing
MAX	Macatawa Area Express Data Archive	The transit data archive for the MAX. Used by FTA and MDOT Office of Public Transportation.	Planned
	Macatawa Area Express Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by MAX.	Existing
	MAX Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	MAX Kiosks	Kiosks for dissemination of transit traveler information. Kiosks can also be used for the purchase and recharging of electronic fare payment cards.	Planned
	MAX Transit Center CCTV Surveillance	CCTV surveillance at MAX transit center.	Planned
	MAX Vehicles	Transit Vehicles owned by Macatawa Area Express	Existing
	MAX Website	Website with information about fares and schedules. At this time the website is static.	Existing

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT	MDOT Anti-Icing Field Equipment	Roadside equipment located along MDOT routes that collects weather data such as temperature and visibility.	Planned
	MDOT Bay Region TMC	Transportation management center for Bay Region that will include the freeway management system in the Bay Region as well as rural ITS deployments.	Planned
	MDOT CCTV Cameras	Roadside equipment located on local roadways used for traffic condition monitoring and management of incidents.	Planned
	MDOT Commercial Vehicle Permitting System	MDOT system for tracking and monitoring oversize and overweight permits for commercial vehicles.	Planned
	MDOT DMS	Roadside equipment on MDOT routes used to share traveler information with motorists through dynamic messaging.	Planned
	MDOT Drawbridge Control Equipment	Roadside equipment located on MDOT drawbridges that close approaching roadways or stop traffic prior to the drawbridge opening to waterway traffic.	Existing
	MDOT Drawbridge Management Center	Management of the waterways used by boats and ferries and the roadways used by vehicles.	Existing
	MDOT Drawbridge Notification Equipment	Roadside equipment located on MDOT drawbridges that send notifications when the drawbridge is open for waterway traffic.	Existing
	MDOT ESS	Environmental sensor stations located on MDOT routes that collect information about the roadways such as temperature and moisture levels.	Planned
	MDOT Field Sensors	Roadway equipment located on MDOT roadways used to detect vehicle volumes and/or speeds. This information is used in the operation of the traffic signal system and collected by the TOC. MDOT field sensors include VIVDS and any other vehicle detection.	Planned
	MDOT Frost Tube Sensors	Roadside equipment located along MDOT routes that collect data from frost tube sensors.	Planned
	MDOT Grand Region Commercial Vehicle Parking Management System	System operated on MDOT routes that monitors available commercial vehicle parking at rest areas and other key locations.	Planned

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT (continued)	MDOT Grand Region Office	The Grand Region Office serves as a data collection and dissemination point for traffic information in the Grand Region. This includes coordination with other agencies such as public safety, emergency management, and transit.	Existing
	MDOT Grand Region TSCs	MDOT field office that oversees road construction and maintenance on MDOT facilities. Most maintenance and snow removal in this region is achieved through contract agencies.	Existing
	MDOT Grand Traverse County TMC	Co-located traffic operations center in Traverse City. Responsible for the operation of the ITS equipment located in Traverse City and the surrounding areas in the North Region.	Planned
	MDOT Maintenance and Construction Field Personnel	MDOT field forces that operate and maintain MDOT facilities.	Existing
	MDOT Maintenance Vehicles	Michigan Department of Transportation vehicles used in maintenance operations.	Existing
	MDOT MI Drive Website	Website for Michigan Department of Transportation.	Existing
	MDOT MITSC	MDOT traffic management center located in the Metro Region.	Existing
	MDOT North Region TMC	MDOT traffic management center located in the North Region.	Planned
	MDOT Office of Communications	Michigan Department of Transportation responsible for the dissemination of traffic information to the media and public.	Existing
	MDOT Planning Division Data Warehouse	Archive that contains historical traffic data such as volume and speed information.	Existing
	MDOT Roadside Equipment for AHS	Equipment located along MDOT routes that allows communication between roadside devices and vehicles.	Planned
	MDOT Roadside Intersection Collision Avoidance Equipment	Equipment located along MDOT routes that communicates between multiple roadside devices and vehicles to alert of unsafe travel conditions or conditions conducive to crashes.	Planned
	MDOT Roadside Signing Equipment	Equipment located along MDOT routes that provide data through dynamic messaging or in-vehicle messaging.	Planned

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT (continued)	MDOT Security Monitoring Field Equipment	Roadside equipment located on MDOT routes that is used for monitoring key infrastructure elements from damage or attacks. These elements include structures such as bridges or dams.	Planned
	MDOT Service Patrol Dispatch	Provides efficient use of resources to assist motorists in need on MDOT facilities.	Planned
	MDOT Service Patrol Vehicles	Fully equipped vehicles that provide motorist assistance to vehicles in need on MDOT facilities.	Planned
	MDOT Statewide TMC - Lansing	MDOT traffic management center located in Lansing.	Planned
	MDOT Superior Region TMC	MDOT traffic management center located in the Superior Region.	Planned
	MDOT Traffic Signals	Multiple traffic signals interconnected and operated by MDOT.	Existing
	MDOT Traveler Information Database	MDOT maintained database for collecting and disseminating road condition data about construction and maintenance activities, incidents, and special events.	Planned
	MDOT Traveler Information Kiosks	Interactive kiosks that provides users the ability to request and received transportation information.	Planned
	MDOT Weigh-in-Motion	In-road equipment that monitors vehicle weights.	Existing
	MDOT West Michigan TMC	MDOT traffic management center located in Grand Rapids.	Existing
	MDOT Work Zone Safety Monitoring Equipment	Portable ITS equipment that can be used in work zones to more efficiently manage traffic and provide traveler information. Includes CCTV, vehicle detection, and/or DMS.	Planned
	Michigan 511 System	511 Traveler information system central server.	Planned
	Michigan 511 Voice Response System	Michigan 511 Interactive Voice Response system. This is the customer interface component of the 511 system.	Planned
	Other MDOT Region TSCs	Local MDOT offices outside of the Grand Region that oversee the operations and maintenance on MDOT facilities.	Existing
Media	Local Print and Broadcast Media	Local media that provide traffic or incident information to the public.	Existing

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MSP	CJIC Database	Criminal Justice Information Center Database stores criminal justice data and can be accessed by multiple agencies.	Existing
	MIOC	Michigan Intelligence Operations Center. Provides 24-hour statewide information sharing among local, state, and federal public safety agencies and private sector organizations in order to facilitate the collection, analysis, and dissemination of intelligence relevant to terrorism and public safety.	Existing
	MSP District 6 Dispatch - Rockford	Michigan State Police dispatch for the Grand Region. Provides call-taking and dispatch for public safety agencies.	Existing
	MSP Headquarters - East Lansing	Michigan State Police headquarters that oversees operations of MSP.	Existing
	MSP Motor Carrier Division	Responsible for monitoring commercial vehicle regulations on MDOT routes.	Existing
	MSP Motor Carrier Division Enforcement	Responsible for enforcing commercial vehicle regulations on MDOT routes.	Existing
	MSP Office of Highway Safety Planning	Manages crash data for MDOT routes.	Existing
	MSP Toll Free Winter Road Conditions Phone Number	Winter weather information operated from November through March to share winter weather conditions as received.	Existing
	MSP Vehicles	Public Safety vehicles owned and operated by Michigan State Police. Includes the ITS equipment installed on the cruisers (AVL, MDTs, etc.).	Existing
	MSP Winter Travel Advisory Website	Traveler Information website operated by Michigan State Police for dissemination of winter weather advisories	Existing
Muskegon Area Transit System	Muskegon Area Transit System CCTV Surveillance	CCTV surveillance at the Muskegon Area Transit System Transit Center.	Planned
	Muskegon Area Transit System Data Archive	The transit data archive for the Muskegon Area Transit System. Used by FTA and MDOT Office of Public Transportation.	Planned
	Muskegon Area Transit System Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by Muskegon Area Transit System.	Existing

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Muskegon Area Transit System (continued)	Muskegon Area Transit System Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	Muskegon Area Transit System Kiosks	Kiosks for dissemination of transit traveler information. Kiosks can also be used for the purchase and recharging of electronic fare payment cards.	Planned
	Muskegon Area Transit System Vehicles	Transit Vehicles owned by Muskegon Area Transit	Existing
	Muskegon Area Transit System Website	Website with information about fares and schedules. At this time the website is static.	Existing
NOAA	National Weather Service	Provides official US weather, marine, fire and aviation forecasts, warnings, meteorological products, climate forecasts, and information about meteorology.	Existing
	NWS Weather Stations	National Weather Service Field equipment that collects weather data such as temperature and visibility	Existing
Other Agencies	Multimodal Service Provider	Agency that offers services across multiple transportation modes.	Planned
	Private Concierge Provider	Private entities that provides customized services to the traveler. This service is usually subscription based.	Existing
Other Elements	Potential Obstacles	Obstacles that could interfere with the safe operation of vehicles.	Existing
	Roadway Environment	All objects and conditions in the vicinity of the traveler that can affect the operations of the traveler.	Existing
Private Information Service Provider	Private Sector ISP	Private entities that collect and disseminate traffic information.	Existing
	Private Sector Traveler Information Services	Website sponsored by a private entity. Often this information is provided through a subscription.	Existing
Private Operators	Contractor Smart Zone Equipment	Smart Work Zone Equipment owned by private contractor. Portable ITS equipment that can be used in work zones to more efficiently manage traffic and provide traveler information. Includes CCTV, vehicle detection, and/or DMS.	Existing
	Private Fleet Operators	Private companies that proactively manage and operate their fleet routing. Includes reactions to incidents and possible delays.	Existing
	Private Parking Operator	System operated on private property that monitors available commercial vehicle parking.	Existing

Table 5 - Grand Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Private Transportation Providers	Private Transportation Providers	Private providers of transportation services in the Region such as taxis and intercity bus services.	Existing
Rail Operators	Rail Operator Wayside Equipment	Equipment located along the tracks including railroad crossing gates, bells, and lights as well as the interface to the traffic signal controller indicating the presence of a train.	Planned
Regional Demand Response Transit Providers	Regional Demand Response Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	Regional Demand Response Transit Provider Data Archive	The transit data archive for the Regional Demand Responsive Transit Providers Data Archive. Used by FTA and MDOT Office of Public Transportation.	Planned
	Regional Demand Response Transit Provider Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by Regional Demand Responsive Transit Authorities.	Planned
	Regional Demand Response Transit Provider Transit Center CCTV Surveillance	CCTV surveillance at the Regional Demand Response Transit Providers Center	Planned
	Regional Demand Response Transit Provider Vehicles	Transit Vehicles owned by the regional demand responsive transit providers.	Existing
	Regional Demand Response Transit Provider Website	Website with information about fares and schedules. At this time the website is static.	Planned
System Users	Archived Data Users	Those who request information from the data archive systems	Existing
	Commercial Vehicle	Privately owned commercial vehicles that travel throughout the Region. Included in the architecture to cover HAZMAT incident reporting.	Existing
	Driver	Individual operating a vehicle on roadways within the region	Existing
	Other Vehicle	Vehicles outside of the control of the driver.	Existing
	Private Travelers Personal Computing Devices	Computing devices that travelers use to access public information.	Existing
	Private Vehicles	Vehicles operated by the public.	Existing
	Traveler	Individual operating a vehicle on roadways within the Region	Existing

3.3.3 Top Level Regional System Interconnect Diagram

A system interconnect diagram, or "sausage diagram" (shown previously in **Table 4**), shows the systems and primary interconnects in the Region. The National ITS Architecture interconnect diagram has been customized for the Grand Region based on the system inventory and information gathered from the stakeholders. **Table 5** summarizes the existing and planned ITS elements for the Grand Region in the context of a physical interconnect. Subsystems and elements specific to the Region are called out in the boxes surrounding the main interconnect diagram, and these are color-coded to the subsystem with which they are associated.

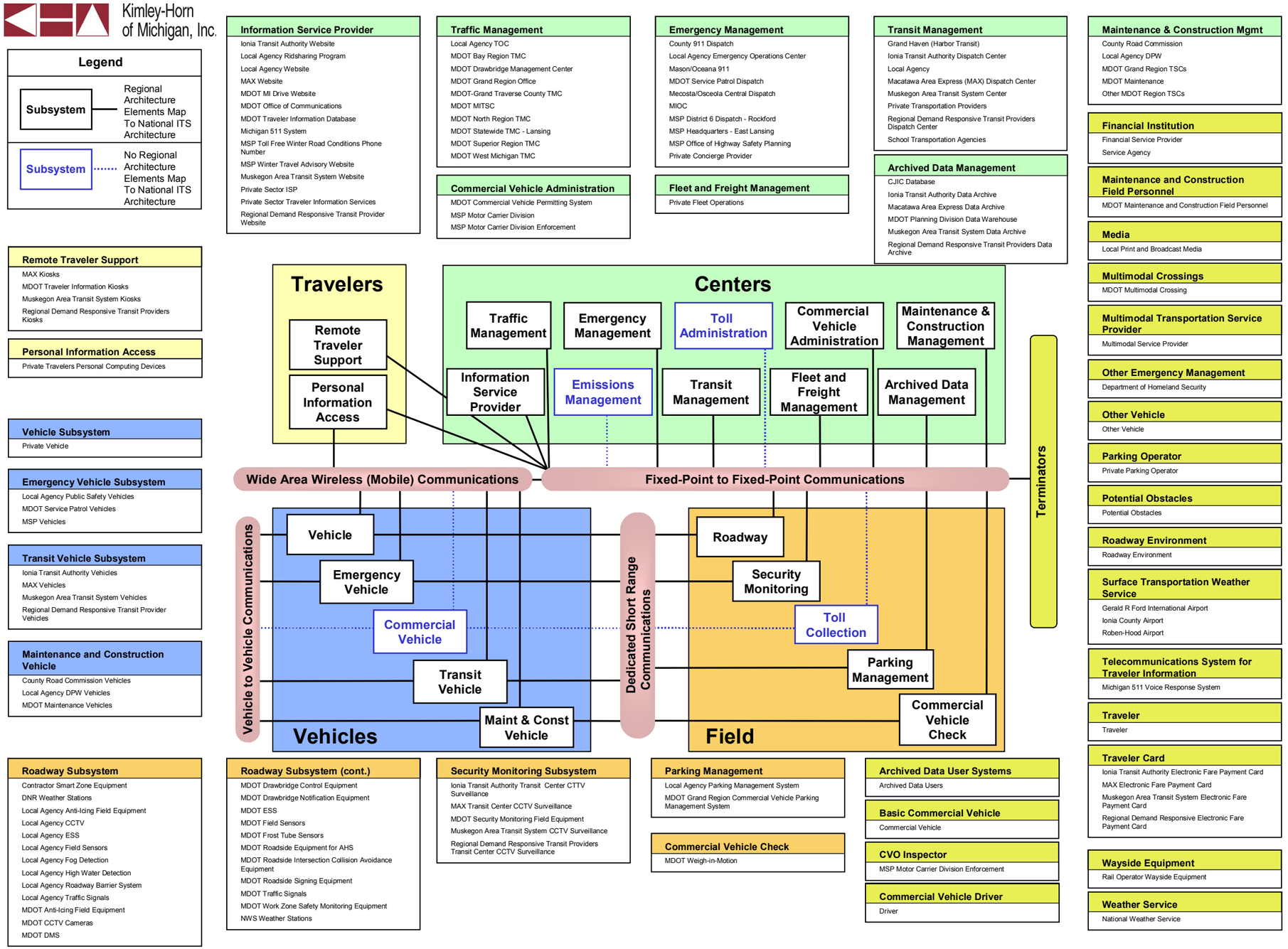

Figure 4 - Grand Regional System Interconnect Diagram

3.4 Market Packages

Upon completion of the system inventory, the next step in the development of the architecture was to identify the transportation services that are important to the Grand Region. In the National ITS Architecture, services are referred to as market packages. Market packages can include several stakeholders and elements that work together to provide a service in the Region. Examples of market packages from the National ITS Architecture include Network Surveillance, Traffic Information Dissemination, and Transit Vehicle Tracking. There are currently a total of 85 market packages identified in the National ITS Architecture Version 5.1. **Appendix A** provides definitions for each of the National ITS Architecture market packages.

The market packages are grouped together into eight ITS service areas: Traffic Management, Emergency Management, Maintenance and Construction Management, Public Transportation Management, Commercial Vehicle Operations, Traveler Information, Archived Data Management, and Vehicle Safety.

3.4.1 Selection and Prioritization of Regional Market Packages

In the Grand Region, the National ITS Architecture market packages were reviewed by the stakeholders and selected based on the relevance of the service that the market package could provide to the Region. Forty-eight market packages were selected for implementation in the Region. They are identified in **Table 6**. Stakeholders prioritized the selected market packages during the workshop, and the table organizes the market packages into service areas and priority groupings. These priorities are based on the stakeholders' opinion of need and do not necessarily represent the timeframe for funding of the deployments. These priorities can also be affected by several other factors such as existing infrastructure, dependency on other systems, and the maturity of the technology associated with the market package.

After selecting the market packages that were applicable for the Region, stakeholders reviewed each market package and the elements that could be included to customize it for the Region. This customization is discussed further in the following section.

Table 6 - Grand Region Market Package Prioritization by Functional Area

High Priority Market Packages	Medium Priority Market Packages	Low Priority Market Packages
Travel and Traffic Management		
ATMS01 Network Surveillance ATMS03 Surface Street Control ATMS06 Traffic Information Dissemination ATMS07 Regional Traffic Control ATMS08 Traffic Incident Management System ATMS20 Drawbridge Management	ATMS13 Standard Railroad Grade Crossing ATMS21 Roadway Closure Management	ATMS02 Probe Surveillance ATMS16 Parking Facility Management ATMS17 Regional Parking Management
Emergency Management		
EM01 Emergency Call-Taking and Dispatch EM02 Emergency Routing EM06 Wide-Area Alert	EM03 Mayday Support	EM04 Roadway Service Patrols EM05 Transportation Infrastructure Protection EM07 Early Warning System EM09 Evacuation and Reentry Management EM10 Disaster Traveler Information
Maintenance and Construction Management		
MC01 Maintenance and Construction Vehicle and Equipment Tracking MC03 Road Weather Data Collection MC04 Weather Information Processing and Distribution MC06 Winter Maintenance MC08 Work Zone Management	MC05 Roadway Automated Treatment MC09 Work Zone Safety Monitoring	MC10 Maintenance and Construction Activity Coordination
Public Transportation Management		
APTS1 Transit Vehicle Tracking APTS5 Transit Security	APTS2 Transit Fixed-Route Operations APTS3 Demand Response Transit Operations APTS4 Transit Passenger and Fare Management APTS6 Transit Maintenance APTS8 Transit Traveler Information	APTS7 Multi-modal Coordination
Commercial Vehicle Operations		
CVO06 Weigh-in-Motion	CVO04 CV Administration Process	
Traveler Information		
ATIS1 Broadcast Traveler Information ATIS2 Interactive Traveler Information	ATIS4 Dynamic Route Guidance ATIS5 ISP Based Route Guidance ATIS9 In Vehicle Signing	ATIS8 Dynamic Ridesharing
Archived Data Management		
AD1 ITS Data Mart AD3 ITS Virtual Data Warehouse		

Table 6 - Grand Region Market Package Prioritization by Functional Area

Advanced Vehicle Safety System		
AVSS10 Intersection Collision Avoidance AVSS11 Automated Highway System		

3.4.2 Customized Market Packages

The market packages in the National ITS Architecture were customized to reflect the unique systems, subsystems, and terminators in the Grand Region. Each market package is shown graphically with the market package name, local agencies involved and desired data flows included. Market packages represent a service that will be deployed as an integrated capability.

Figure 5 is an example of an ATMS market package for Surface Street Control that has been customized for the Region. This market package shows the two subsystems, Traffic Management and Roadway, and the associated entities (Local Agency TOC and Local Agency Traffic Signals) for surface street control in the Region. Data flows between the subsystems indicate what information is being shared. The remainder of the market packages that were customized for the Grand Region is shown in **Appendix B**.

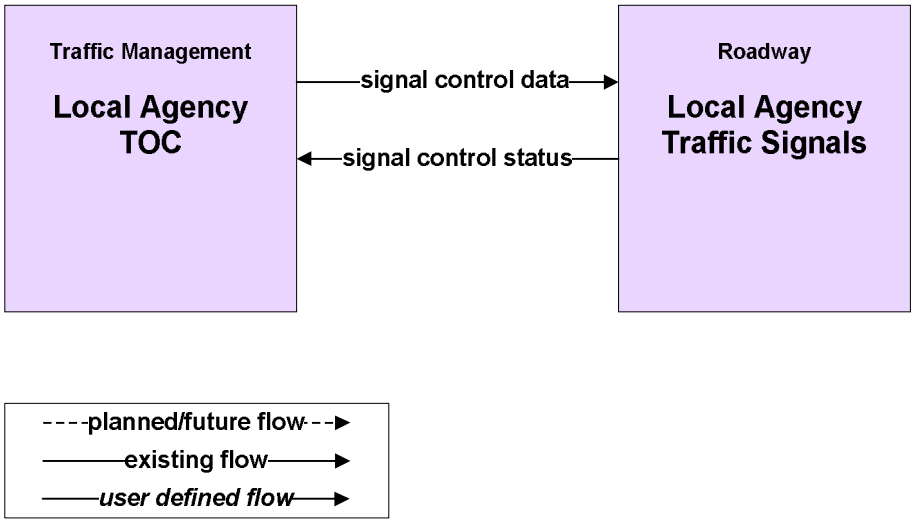

Figure 5 - Example Market Package Diagram: Surface Street Control

3.4.3 Regional ITS Needs and Customized Market Packages

Input received from stakeholders at the Architecture Workshop provided valuable input for the market package customization process. The specific needs identified are included in **Table 7**. The table also identifies which market package documents the particular ITS need.

Table 7 - Regional ITS Needs and Corresponding Market Packages

ITS Need	Market Package
Traffic Management and Traveler Information	
Need remote access to closed loop systems so MDOT can adjust timing plans	ATMS03
Need system for managing recurring congestion in Grand Haven	ATMS01 ATMS03 ATMS08
Need incident management system that helps communicate with Media	ATMS06 ATMS08
Need to integrate Traffic Management Center with EMS CAD	ATMS06 ATMS08
Need plans for traffic management during special events (Coast Guard Festival, Grand Haven)	ATMS01 ATMS06 ATMS08
Need CCTV surveillance in specific locations	ATMS01
Need animal avoidance solutions on local roads, not necessarily on MDOT routes	ATMS01
Need assistance building communications between agencies	ATMS06 ATMS07
Public Transportation Management	
Need AVL technology for transit vehicles	APTS1
Need improved traveler information solutions for transit agencies	APTS8
Emergency Management	
Need RWIS devices and warning signs controlled by RWIS	MC03 MC04
Need to link RWIS to Maintenance Personnel	MC04 MC06
Need improved coordination between multiple central dispatch	ATMS03 EM01
Public safety needs access to CCTV camera images	ATMS06
Maintenance and Construction Management	
Need system to manage contracted snow removal (GPS, central database, communication)	MC01 MC06
Need anti-icing systems in key locations	MC05
Commercial Vehicle Operations	
Need permanent Weigh-In-Motion stations outside of Kent County	CVO06
Need system for monitoring frost tube measurements that drive seasonal weight restrictions	MC03
Need improved access to remote WIM sites	CVO06
Traveler Information	
Need DMS in key incident management locations	ATMS06
Archived Data Management	
Need improved method for sharing crash data	AD1 AD3
Need method for sharing historical data	AD1 AD3

3.5 Architecture Interfaces

While it is important to identify the various systems and stakeholders that are part of a regional ITS, a primary purpose of the architecture is to identify the connectivity between transportation systems in the Grand Region. The system interconnect diagram shown previously in **Figure 4** showed the high-level relationships of the subsystems and terminators in the Grand Region and the associated local projects and systems. The customized market packages represent services that can be deployed as an integrated capability and the market package diagrams show the information flows between the subsystems and terminators that are most important to the operation of the market packages. How these systems interface with each other is an integral part of the overall ITS architecture.

3.5.1 Element Connections

There are a large number of different elements identified as part of the Grand Regional ITS Architecture. These elements include traffic management centers, transit vehicles, dispatch systems, emergency management agencies, media outlets, and others—essentially, all of the existing and planned physical components that contribute to the regional ITS. Interfaces have been identified for each element in the Grand Region ITS Architecture and each element has been mapped to those other elements with which it must interface. The Turbo Architecture software can generate interconnect diagrams for each element in the Region that show which elements are connected to one another. **Figure 6** is an example of a context style interconnect diagram from the Turbo database output. This particular interconnect diagram is for the MDOT MI Drive Website and is called a context diagram because it shows every element in the architecture that the website connects to.

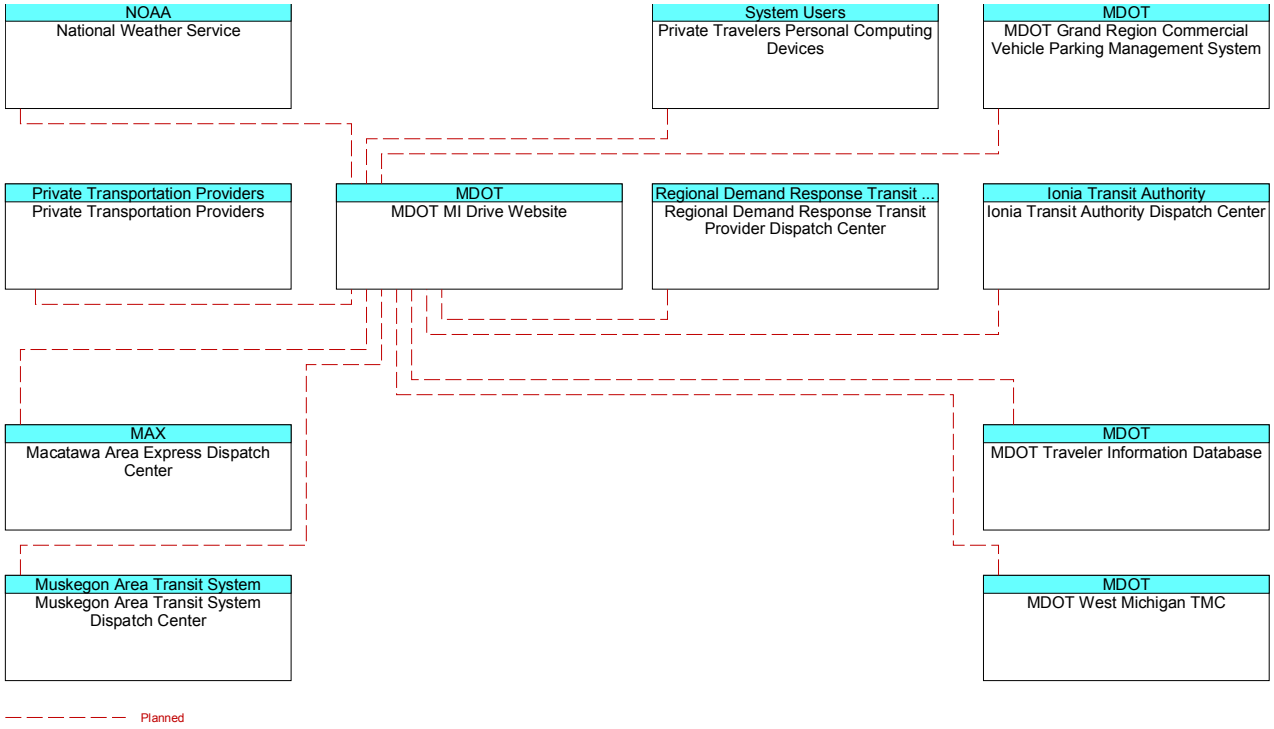

Figure 6 - Example Interconnect Diagram: MDOT MI Drive Website

3.5.2 Data Flows Between Elements

In the market package diagrams, flows between the subsystems and terminators define the specific information (data) that is exchanged between the elements and the direction of the exchange. The data flows could be requests for information, alerts and messages, status requests, broadcast advisories, event messages, confirmations, electronic credentials, and other key information requirements. Turbo Architecture can be used to output flow diagrams and can be filtered by market package for ease of interpretation; however, it is important to remember that custom data flows will not show up in diagrams that are filtered by market package. An example of a flow diagram for the MDOT Traffic Signals that has been filtered for ATMS03 – Surface Street Control for MDOT Traffic Signal System is shown in **Figure 7**.

The flow diagrams can vary greatly in complexity and, in turn, legibility. **Figure 8** shows a more complex flow diagram for ATMS06 – Traffic Information Dissemination – MDOT West Michigan TMC.

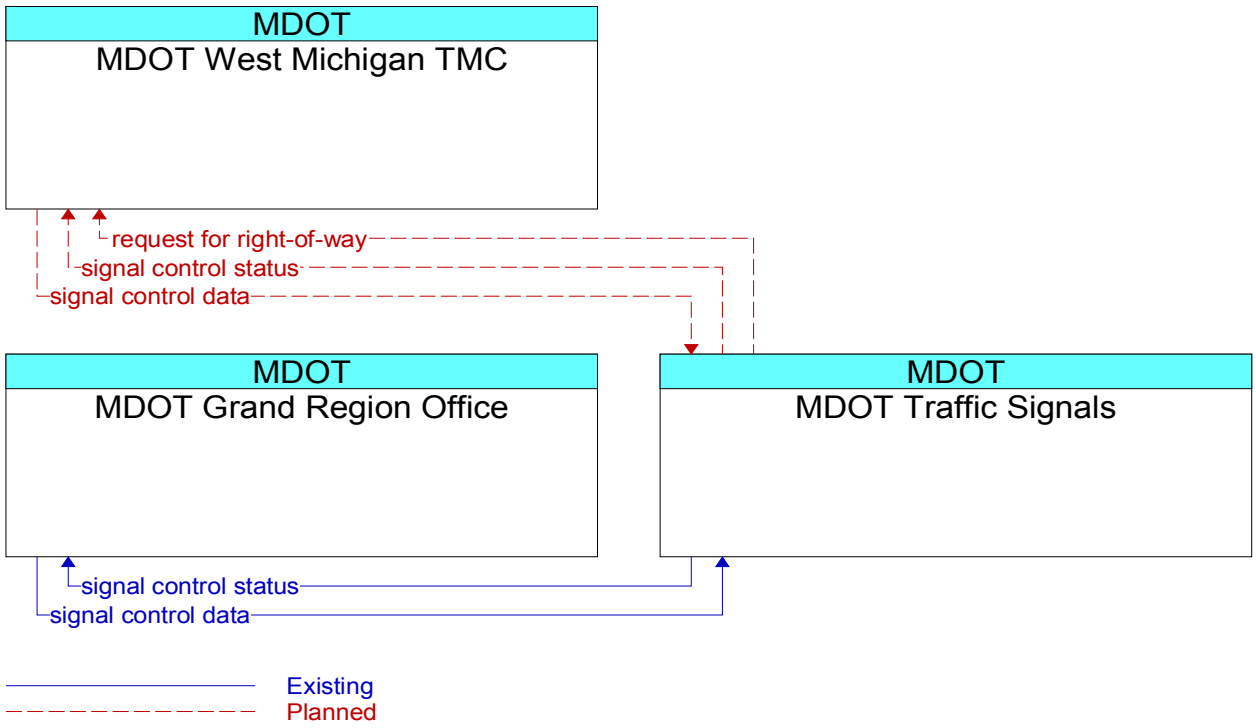

Figure 7 - Example Flow Diagram: ATMS03 – Surface Street Control for MDOT Traffic Signal System

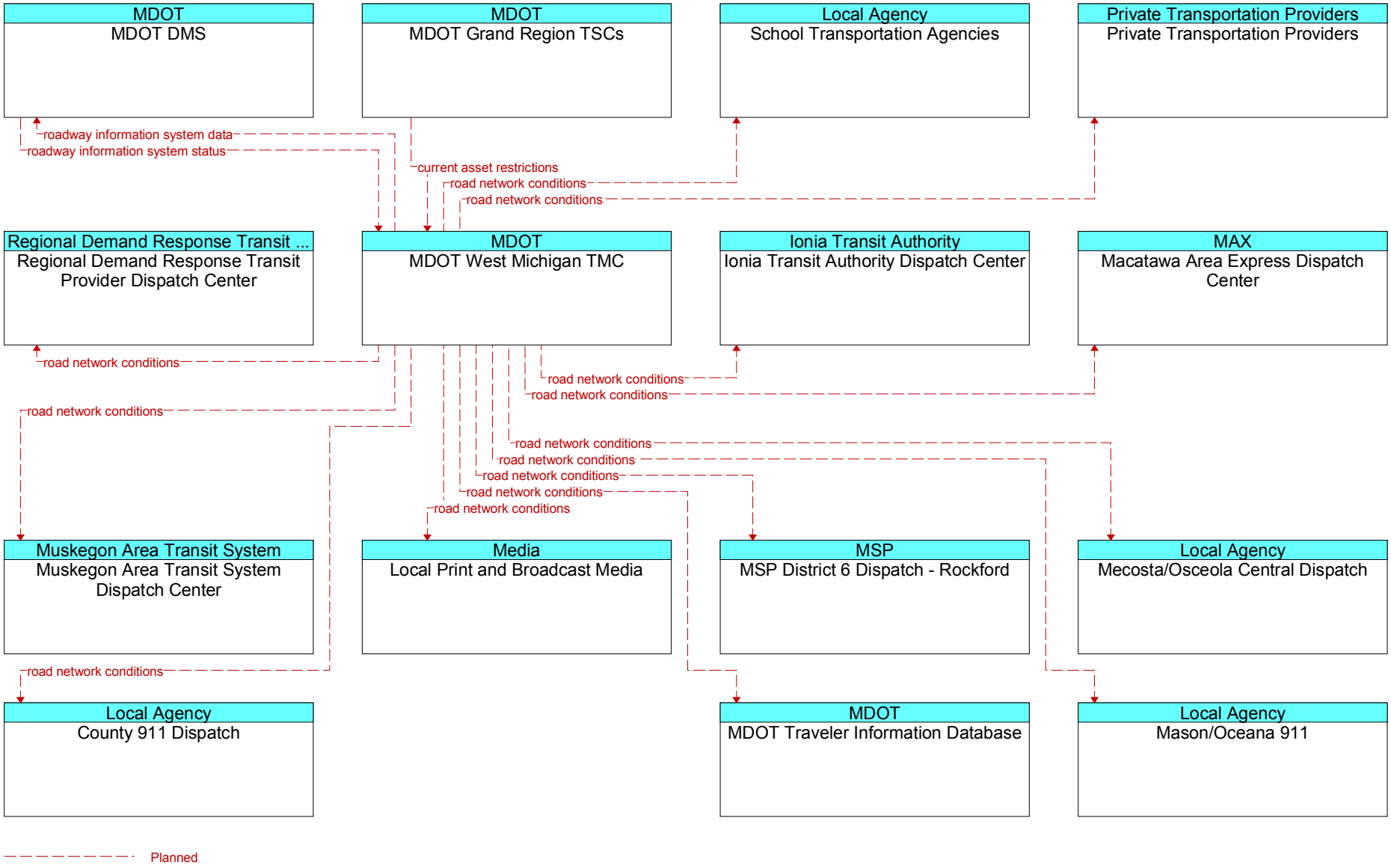

Figure 8 - Example Flow Diagram: ATMS06 – Traffic Information Dissemination – MDOT West Michigan TMC

In addition to market package style flow diagrams, Turbo Architecture has the ability to create flow diagrams that show only the connections between two or three specific elements or context diagrams that sow all of the flows that involve an element. Filtering the diagrams to generate specific scenarios can be very useful during the project implementation process. For example, **Figure 9** shows the flows between MDOT Traveler Information Database and MDOT Traveler Information Kiosks. While this is a portion of the planned interactions, it could also be useful to use a context diagram for the element, as shown in **Figure 10** to view all of the other interactions so that the project can be designed with the future in mind. Context style flow diagrams can get very large and complicated for elements with lots of connections such as a TMC.

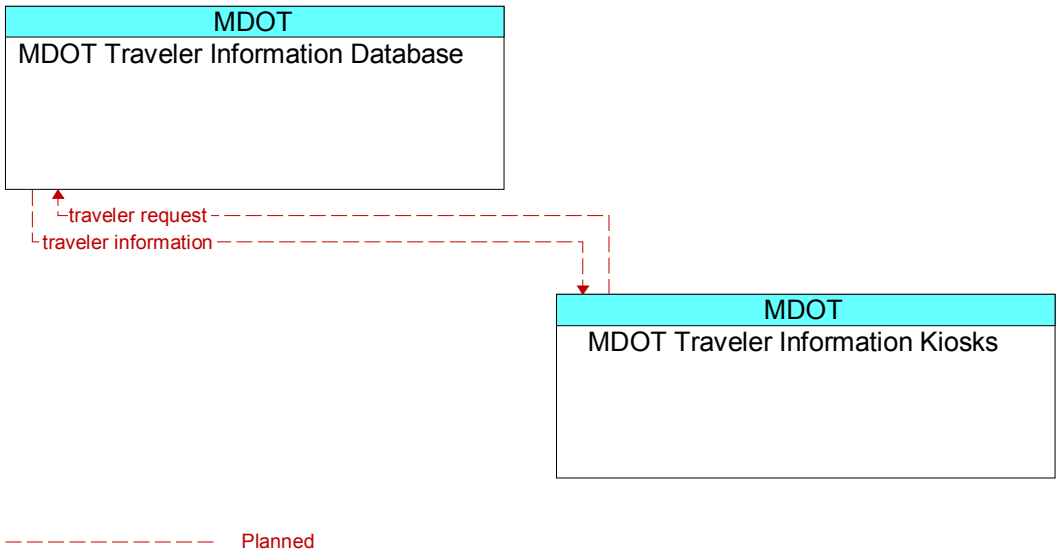

Figure 9 - Example Two Element Flow Diagram

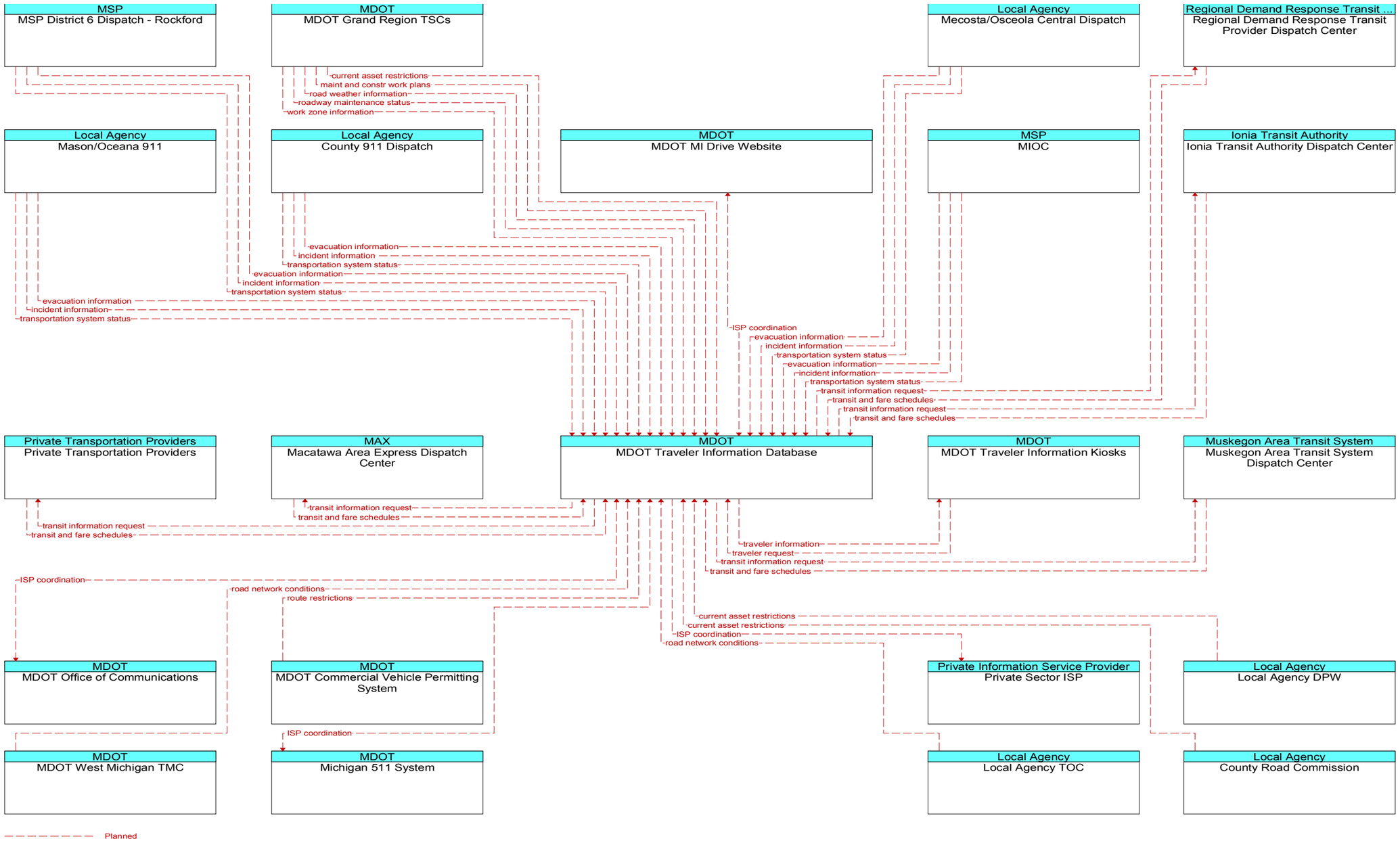

Figure 10 - Example Context Flow Diagram: MDOT Traveler Information Database

4. APPLICATION OF THE REGIONAL ITS ARCHITECTURE

Once a region has identified the desired components of ITS for their area and established which agencies and systems need to be connected, the structure of the National ITS Architecture assists with the region's planning and implementation. This section addresses the application of the Regional ITS Architecture in the Grand Region. The National ITS Architecture provides recommendations for standards and functional requirements that should be considered when implementing ITS elements. In addition, an operational concept has been developed for the Region and documents the roles and responsibilities of stakeholders in the operation of the regional ITS. The implementation of ITS in the Grand Region will likely require interagency agreements. Potential agreements have been identified based on the desired data flows identified in the Grand Region. The ITS Architecture and ITS Deployment Plan developed as part of this process will be incorporated into the existing planning process for the Region to ensure that the maximum benefit is realized from the development effort.

4.1 Functional Requirements

Functions are a description of what the system has to do. In the National ITS Architecture, functions are defined at several different levels, ranging from general subsystem descriptions through somewhat more specific equipment package descriptions to Process Specifications that include substantial detail. Guidance from the USDOT on developing a Regional ITS Architecture recommends that each Region determine the level of detail of the functional requirements for their Region. In the Grand Region, it is recommended that the development of detailed functional requirements such as the "shall" statements included in Process Specifications for a system be developed at the project level. These detailed "shall" statements identify all functions that a project or system needs to perform.

For the Grand Regional ITS Architecture, functional requirements have been identified at two levels. The customized market packages, discussed previously in Section 3.4.2, describe the services that ITS needs to provide in the Region and the architecture flows between the elements. These market packages and data flows describe what the systems in the Grand Region have to do and the data that needs to be shared among elements.

At a more detailed level, functional requirements for the Grand Region are described in terms of functions that each element in the architecture performs or will perform in the future. **Appendix C** contains a table that summarizes the functions by element.

4.2 Standards

Standards are an important tool that will allow efficient implementation of the elements in the Grand Regional ITS Architecture over time. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances, vendors change, and as new approaches evolve. The USDOT's ITS Joint Program Office is supporting Standards Development Organizations (SDOs) with an extensive, multi-year program of accelerated, consensus-based standards development to facilitate successful ITS deployment in the United States. **Table 8** identifies each of the ITS standards that could apply to the Grand Regional ITS Architecture. These standards are based on the physical subsystem architecture flows previously identified in Section 3.5.2.

Table 8 - Grand Region Applicable ITS Standards

SDO	Document ID	Title
ANSI	ANSI TS286	Commercial Vehicle Credentials
AASHTO/ITE/NEMA	NTCIP 1101	Simple Transportation Management Framework (STMF)
	NTCIP 1102	Octet Encoding Rules Base Protocol
	NTCIP 1103	Transportation Management Protocols
	NTCIP 1104	Center-to-Center Naming Convention Specification
	NTCIP 1105	CORBA Security Service Specification
	NTCIP 1106	CORBA Near-Real Time Data Service Specification
	NTCIP 1201	Global Object Definitions
	NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units
	NTCIP 1203	Object Definitions for DMS
	NTCIP 1204	Environmental Sensor Station Interface Standard
	NTCIP 1205	Object Definitions for CCTV Camera Control
	NTCIP 1206	Object Definitions for Data Collection and Monitoring (DCM) Devices
	NTCIP 1208	Object Definitions for CCTV Switching
	NTCIP 1209	Data Element Definitions for Transportation Sensor Systems
	NTCIP 1210	Field Management Stations – Part 1: Object Definitions for Signal System Masters
	NTCIP 1211	Object Definitions for Signal Control and Prioritization
	NTCIP 1401	TCIP Common Public Transportation Objects
	NTCIP 1402	TCIP Incident Management Objects
	NTCIP 1403	TCIP Passenger Information Objects
	NTCIP 1404	TCIP Scheduling/Runcutting Objects
	NTCIP 1405	TCIP Spatial Representation Objects
	NTCIP 1406	TCIP On-Board Objects
	NTCIP 1407	TCIP Control Center Objects
	NTCIP 1408	TCIP Fare Collection Business Area Objects
	NTCIP 2101	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile
	NTCIP 2102	Point to Multi-Point Protocol Using Frequency Shift Keying Modem Subnetwork Profile
	NTCIP 2103	Point-to-Point Protocol Over RS-232 Subnetwork Profile
	NTCIP 2104	Ethernet Subnetwork Profile
	NTCIP 2201	Transportation Transport Profile
	NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile
	NTCIP 2301	STMF Application Profile
	NTCIP 2302	Trivial File Transfer Protocol Application Profile
	NTCIP 2303	File Transfer Protocol Application Profile
	NTCIP 2304	Application Profile for DATEX-ASN (AP-DATEX)
	NTCIP 2305	Application Profile for CORBA (AP-CORBA)
	NTCIP 2306	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications
	NTCIP 2501	Information Profile for DATEX
	NTCIP 2502	Information Profile for CORBA

Table 8 - Grand Region Applicable ITS Standards

SDO	Document ID	Title
ASTM	ASTM E2158-01	Standard Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz Band
	ASTM E2259-xx	Standard Specification for Metadata to Support Archived Data Management Systems
	ASTM PS 105-99	Standard Provisional Specification for DSRC Data Link Layer
IEEE	IEEE Std 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications
	IEEE 1512.1-2003	Standard for Traffic Incident Management Message Sets for Use by EOCs
	IEEE 1512.2-2004	Standard for Public Safety Incident Management Message Sets (IMMS) for use by EOCs
	IEEE 1512.3-2002	Standard for Hazardous Material IMMS
	IEEE 1512-2000	Standard for Common IMMS for use by EOCs
	IEEE 1570-2002	Standard for Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection
	IEEE 1609.1	Resource Manager for DSRC 5.9 GHz
	IEEE 1609.2	Application Services (Layers 6,7) for DSRC 5.9 GHz
	IEEE 1609.3	Communications Services (Layers 4,5) for DSRC 5.9 GHz (Future Standard)
	IEEE 1609.4	Medium Access Control (MAC) Extension and the MAC Extension Management Entity for DSRC 5.9 GHz
	IEEE 802.11	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band DSRC MAC and Physical Layer Specifications
	IEEE 802.2	Logical Link (Layer 2) for DSRC 5.9 GHz
	IEEE P1512.4	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers
ISO	ISO 21210	Networking Services (Layer 3) for DSRC 5.9 GHz
SAE	ITE TM 1.03	Standard for Functional Level Traffic Management Data Dictionary
	ITE TM 2.01	Message Sets for External TMC Communication
	SAE J2266	Location Referencing Message Specification
	SAE J2313	On-Board Land Vehicle Mayday Reporting Interface
	SAE J2354	Message Set for Advanced Traveler Information System (ATIS)
	SAE J2369	Standard for ATIS Message sets Delivered Over Reduced Bandwidth Media
	SAE J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards
	SAE J2540-1	Radio Data System Phrase Lists
	SAE J2540-2	International Traveler Information Systems Phrase Lists
	SAE J2540-3	National Names Phrase List

4.3 Operational Concepts

An operational concept documents each stakeholder's current and future roles and responsibilities across a range of transportation services, as grouped in the Operational Concepts section of Turbo Architecture, in the operation of the regional ITS. The services covered are:

- ***Arterial Management*** – The development of signal systems that react to changing traffic conditions and provide coordinated intersection timing over a corridor, an area, or multiple jurisdictions.
- ***Highway Management*** – The development of systems to monitor freeway (or tollway) traffic flow and roadway conditions, and provide strategies such as ramp metering or lane access control to improve the flow of traffic on the freeway. Includes systems to provide information to travelers on the roadway.
- ***Incident Management*** – The development of systems to provide rapid and effective response to incidents. Includes systems to detect and verify incidents, along with coordinated agency response to the incidents.
- ***Emergency Management*** – The development of systems to provide emergency call taking, public safety dispatch, and emergency operations center operations.
- ***Maintenance and Construction Management*** – The development of systems to manage the maintenance of roadways in the Region, including winter snow and ice clearance. Includes the managing of construction operations.
- ***Transit Management*** – The development of systems to more efficiently manage fleets of transit vehicles or transit rail. Includes systems to provide transit traveler information both pre-trip and during the trip.
- ***Electronic Payment*** – The development of electronic fare payment systems for use by transit and other agencies (e.g., parking).
- ***Commercial Vehicle Operations*** – The development of systems to facilitate the management of commercial vehicles (e.g., electronic clearance).
- ***Traveler Information*** – The development of systems to provide static and real time transportation information to travelers.
- ***Archived Data Management*** – The development of systems to collect transportation data for use in non-operational purposes (e.g., planning and research).
- ***Advanced Vehicle Safety*** – The development of systems to support private sector vehicle safety initiatives (e.g., intersection collision avoidance).

Table 9 identifies the roles and responsibilities of key stakeholders for a range of transportation services.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Arterial Management	MDOT	Operate and maintain traffic signal systems on MDOT routes not managed by local agencies.
		Operate network surveillance equipment (CCTV Cameras, field sensors, etc.) on MDOT routes not managed by local agencies.
		Provide traffic information reports to regional information service providers.
		Coordinate traffic information and control with Local Agency TOCs and other MDOT TMCs.
	Local Agency	Operate traffic signal systems on local routes.
		Operate network surveillance equipment including CCTV cameras and field sensors on local routes to facilitate traffic signal operations.
		Provide traffic information reports to regional information service providers.
		Provide traffic information to regional agencies including transit, emergency management, maintenance and construction, and the media.
		Coordinate traffic information and control with MDOT West Michigan TMC.
		Coordinate traffic information with other local agencies.
		Coordinate HRI signal adjustments with private rail operators.
		Provide traffic signal preemption for emergency vehicles.
Highway Management	MDOT	Operate network surveillance equipment including CCTV Cameras and field sensors as well as DMS to convey traffic information to travelers on MDOT highway routes.
		Provide traffic information to regional information service providers.
		Provide traffic information to regional transportation agencies and the general public through traffic information devices primarily DMS.
		Coordinate traffic information and control with other MDOT TMCs.
Incident Management (Traffic)	MDOT	Coordinate maintenance resources for incident response with MDOT TSC construction and maintenance operations.
		Perform network surveillance for detection and verification of incidents on MDOT routes.
		Provide incident information to travelers via traffic information devices on highways (eg. DMS).
		Provide incident information to regional emergency responders, including the MSP and local agencies.
		Responsible for the development, coordination, and execution of special traffic management strategies during an evacuation.
		Responsible for the coordination with other traffic operations centers and emergency management agencies for coordinated incident management.
	Local Agency	Perform network surveillance for detection and verification of incidents on local routes.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Incident Management (Traffic) (continued)	Local Agency (continued)	Provide incident information to regional emergency responders, including the MSP and MDOT.
		Coordinate maintenance resources for incident response with MDOT Grand Region TSCs and Local Agencies.
		Responsible for the coordination with other traffic operations centers and emergency management agencies for coordinated incident management.
Incident Management (Emergency)	MSP	Dispatch MSP vehicles for incidents on highways.
		Coordinate incident response with other public safety agencies such as local police, fire, EMS, sheriff as well as MDOT.
		Perform incident detection and verification for the highways within the region and provide this information to traffic and other public safety agencies.
	Local Agency	Dispatch the local agency emergency vehicles to incidents, including the local agency police, fire, and EMS/rescue.
		Coordinate public safety resources for incident response on local routes.
		Coordinate incident response with other public safety agencies (fire, EMS, ambulance, etc.).
		Receive emergency calls for incidents on local routes.
		Coordinate public safety resources for incident response on local routes.
		Perform incident detection and verification on local routes and provide this information to the local agency TOC.
Emergency Management	MSP	Dispatch MSP vehicles to incidents within their jurisdiction.
		Receive AMBER Alert and other wide area alert information from MSP.
		Receive early warning information and threat information from the NWS and local agencies.
		Coordinate with regional emergency management providers, maintenance and construction providers, and regional traffic management providers for emergency plans and evacuation and reentry plans.
		Provide regional traffic, transit, emergency management, and maintenance operations with disaster information to disseminate to the traveling public.
	Local Agency	Participate in incident response, coordination, and reporting.
		Dispatch local agency fire/EMS/police vehicles.
		Perform incident detection and verification on local roadways.
		Receive AMBER Alert and other wide area alert information from MSP.
		Respond to transit emergencies/alarms on-board transit vehicles or at the transit facilities of local transit agencies.
	MIOC	Participate in the incident response, coordination, and reporting.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Maintenance and Construction Management	MDOT	Receive requests for maintenance resources for incident response from regional emergency management agencies.
		Support coordinated response to incidents.
		Responsible for the tracking and dispatch MDOT maintenance vehicles.
		Receive vehicle maintenance conditions from MDOT maintenance and construction vehicle and coordinate fleet management the with MDOT equipment repair facility.
		Collect road weather information with MDOT equipment and distribute it to regional traffic, maintenance, and transit agencies.
		Provide maintenance of state highways within the region, including pavement maintenance, winter maintenance, and construction activities.
		Manage work zones on all MDOT maintenance and construction activities, as well as monitor work zone safety with MDOT field devices and vehicles.
		Coordinate maintenance and construction activities with other regional maintenance and construction agencies.
		Distribute maintenance and construction plans and work zone information to regional information service providers, regional traffic operations, transit operations, emergency operations, rail operations, and the media.
		Perform maintenance of ITS field equipment owned by MDOT.
	Local Agency	Receive a request for maintenance resources for incident response from regional emergency management agencies.
		Coordinate maintenance resources for incidents with other regional maintenance providers.
		Receive vehicle location information from local agency DPW vehicles.
		Dispatch local agency maintenance vehicles.
		Provide maintenance of local routes and MDOT facilities (per contract), including pavement maintenance and construction activities.
	Private Operators	Provide maintenance of local routes and MDOT facilities (per contract), including pavement maintenance and construction activities.
Transit Management	Muskegon Area Transit System	Provide fixed route bus service for Muskegon Area Transit System.
		Provide paratransit bus service for the Muskegon Area Transit System.
		Track and evaluate schedule performance on all Muskegon Area Transit System fixed route and demand response vehicles.
		Provide transit schedule and fare information to the Muskegon Area Transit System website and private sector traveler information service providers.
		Provide a paratransit transit plan from the agency website.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Transit Management (continued)	Muskegon Area Transit System (continued)	Provide transit passenger electronic fare payment on all Muskegon Area Transit System fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Muskegon Area Transit System fixed route and demand response vehicles.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the local public safety agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Muskegon Area Transit System transit operations.
	MAX	Provide fixed route bus service for MAX.
		Provide paratransit bus service for MAX.
		Provide transit schedule and fare information to the MAX website and private sector traveler information service providers.
		Track and evaluate schedule performance on all MAX fixed route and demand response vehicles.
		Provide a paratransit transit plan from the agency website.
		Provide transit passenger electronic fare payment on all MAX fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all MAX fixed route and demand response vehicles.
		Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the local public safety agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from MAX transit operations.
	Ionia Transit Authority	Provide demand response bus service for the Ionia Transit Authority.
		Provide transit schedule and fare information to the Ionia Transit Authority website and private sector traveler information service providers.
		Track and evaluate schedule performance on all Ionia Transit Authority fixed route and demand response vehicles.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Transit Management (continued)	Ionia Transit Authority (continued)	Provide a demand response transit plan from the agency website.
		Provide transit passenger electronic fare payment on all Ionia Transit Authority fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Ionia Transit Authority fixed route and demand response vehicles.
		Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the Local Public Safety Agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Ionia Transit Authority transit operations.
	Regional Demand Responsive Transit Providers	Provide demand response bus service for the Regional Demand Responsive Transit Providers.
		Provide transit schedule and fare information to the Regional Demand Responsive Transit Providers website and private sector traveler information service providers.
		Track and evaluate schedule performance on all Regional Demand Responsive Transit Providers demand response vehicles.
		Provide a demand response transit plan from the agency website.
		Provide transit passenger electronic fare payment on all Regional Demand Responsive Transit Providers demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Regional Demand Responsive Transit Providers demand response vehicles.
		Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Regional Demand Responsive Transit Providers transit operations.

Table 9 - Grand Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Commercial Vehicle Operations	MSP	Provide enforcement of regional permits for overheight/overweight or HAZMAT commercial vehicles.
		Provide first response to commercial vehicle incidents and coordinate for HAZMAT conditions/clean-up.
	MDOT	Provide regional permits (overheight/overweight and HAZMAT) to private fleet systems.
		Provide automated weigh-in-motion inspections for private fleet operations.
		Provide route restriction information to private fleet systems.
		Provide permit information to regional emergency management providers and regional enforcement agencies.
Traveler Information	MDOT	Collection, processing, storage, and broadcast dissemination of traffic, transit, maintenance and construction and weather information to travelers via the 511 Traveler Information System.
		Provide traveler information to private travelers through in vehicle, personal computing devices or kiosks upon request.
		Provide traveler information to the media.
	MSP	Collect traffic information (road network conditions), work zone information, travel times, and weather information.
	Local Agency	Collect traffic information (road network conditions), work zone information, travel times, and weather information.
		Coordinate and share traveler information with all other traveler information providers within the region.
Archived Data Management	MDOT	Collect and archive traffic information from regional traffic management providers and centers, emergency information from MSP and local agency police, and transit information from regional transit agencies for planning purposes.
		Coordinate with MDOT Transportation Planning Division.
	MSP	Collect and archive emergency and incident information from MSP and the region's emergency responders.

4.4 Potential Agreements

The Regional ITS Architecture for the Grand Region has identified many agency interfaces, information exchanges, and integration strategies that would be needed to provide the ITS services and systems identified by the stakeholders in the Region. Interfaces and data flows among public and private entities in the Region will require agreements among agencies that establish parameters for sharing agency information to support traffic management, incident management, provide traveler information, and perform other functions identified in the Regional ITS Architecture.

With the implementation of ITS technologies, integrating systems from one or more agencies, and the anticipated level of information exchange identified in the architecture, it is likely that formal agreements between agencies will be needed in the future. These agreements, while perhaps not requiring a financial commitment from agencies in the Region, should outline specific roles, responsibilities, data exchanges, levels of authority, and other facets of regional operations. Some agreements will also outline specific funding responsibilities, where appropriate and applicable.

Agreements should avoid being specific with regards to technology when possible. Technology is likely to change rapidly and changes to technology could require an update of the agreement if the agreement was not technology neutral. Focus of the agreement should be on the responsibilities of the agencies and the high level information that needs to be exchanged. Depending on the type of agreement being used, agencies should be prepared for the process to complete an agreement to take several months to years. Agencies must first reach consensus on what should be in an agreement and then proceed through the approval process. The approval process for formal agreements varies by agency and can often be quite lengthy, so it is recommended that agencies plan ahead to ensure that the agreement does not delay the project.

When implementing an agreement for ITS, it is recommended that as a first step any existing agreements are reviewed to determine whether they can be amended or modified to include the additional requirements that will come with deploying a system. If there are no existing agreements that can be modified or used for ITS implementation, then a new agreement will need to be developed. The formality and type of agreement used is a key consideration. If the arrangement will be in affect for an extended duration or involve any sort of long term maintenance, then written agreements should be used. Often during long term operations, staff may change and a verbal agreement between agency representatives may be forgotten by new staff.

Common agreement types and potential applications include:

- **Handshake Agreement:** Handshake agreements are often used in the early stage of a project. This type of informal agreement depends very much on relationships between agencies and may not be appropriate for long term operations where staff is likely to change.
- **Memorandum of Understanding (MOU):** A MOU demonstrates general consensus or willingness to participate as part of a particular project but is not typically very detailed.
- **Interagency and Intergovernmental Agreements:** These agreements between public agencies can be used for operation, maintenance, or funding of its projects and systems. They can include documentation on the responsibility of each agency, functions they will provide, and liability.
- **Funding Agreements:** Funding agreements document the funding arrangements for ITS projects. At a minimum, funding agreements include a detailed scope, services to be performed, and a detailed project budget.

- **Master Agreements:** Master agreements include standard contract language for an agency and serve as the main agreement between two entities which guides all business transactions. Use of a master agreement can allow an agency to do business with another agency or private entity without having to go through the often lengthy development of a formal agreement each time.

Table 10 provides a list of existing and potential agreements for the Grand Region based on the interfaces identified in the Regional ITS Architecture. It is important to note that as ITS services and systems are implemented in the Region, part of the planning and review process for those projects should include a review of potential agreements that would be needed for implementation or operations.

Table 10 - Grand Region Potential Agreements

Status	Agreement and Agencies	Agreement Description
Future	**Joint Operations/Shared Control Agreements (Public-Public or Public-Private)** – MDOT, Local Agencies, MSP	These agreements would allow joint operations or control of certain systems and equipment. The agreement should define such items as hours of operation and time of day/day of week when shared control would take effect, circumstances, or incidents when shared control would take effect, notification procedures between the agencies agreeing to shared control arrangements, overriding capabilities of owning agency, etc. Private agencies, such as information service providers that provide traffic reports, could also be part of this agreement.
Future	**Data Sharing and Usage (Public-Public)** – MDOT, Local Agencies, MSP	These agreements would define the parameters, guidelines, and policies for inter- and intra-agency ITS data sharing. This data sharing would support regional activities related to traffic management, incident management, traveler information, and other functions. The terms of this agreement should generally address such items as types of data and information to be shared, how the information will be used (traffic incident information to be shared, displayed on web site for travel information, distributed to private media, etc.), and parameters for data format, quality, security.
Future	**Data Sharing and Usage (Public-Private)** – MDOT, Local Agencies, media	These agreements would define the parameters, guidelines, and policies for private sector (such as the media or other information service providers) use of ITS data. This type of agreement is recommended to define terms of use for broadcasting public-agency information regarding traffic conditions, closures, restrictions, as well as video images. Agreements can also include requirements for the media to 'source' the information (i.e., using the providing agency's logo on all video images broadcast.

4.5 Phases of Implementation

The Regional ITS Architecture will be implemented over time through a series of projects led by both public sector and private sector agencies. Key foundation systems will need to be implemented in order to support other systems that have been identified in the Regional ITS Architecture. The deployment of all of the systems required to achieve the final Regional ITS Architecture build out will occur over many years.

A sequence of projects and their respective time frames have been identified in the Grand Regional ITS Deployment Plan. These projects have been sequenced over a 20-year period, with projects identified for deployment in 5-, 10- and 20-year timeframes.

Some of the key market packages that will provide the functions for the foundation systems in the Grand Region are listed below. Projects associated with these and other market packages identified for the Region have been included in the Grand Regional ITS Deployment Plan.

- Network Surveillance;
- Maintenance and Construction Vehicle Tracking;
- Weather Information Processing and Distribution;
- Surface Street Control;
- Traffic Information Dissemination; and
- Transit Vehicle Tracking.

5. USE AND MAINTENANCE PLAN FOR THE REGIONAL ITS ARCHITECTURE

The ITS Architecture developed for the Grand Region addresses the Region's vision for ITS implementation at the time the plan was developed. Stakeholders invested a considerable amount of effort in the development of the Regional ITS Architecture and Regional ITS Deployment Plan. As the Region grows, needs will change, and, as technology progresses, new ITS opportunities will arise. Shifts in regional needs and focus as well as changes in the National ITS Architecture will necessitate that the Grand Region ITS Architecture be updated to remain a useful resource for the Region.

The following section outlines how the Region and its stakeholders can work with the MDOT ITS Program Office to ensure projects are in conformity and also provide updates as ITS evolves in the region.

5.1 Process for Determining Architecture Conformity

The Grand Regional ITS Architecture and Deployment Plan documents the customized market packages that were developed as part of the ITS architecture process. To satisfy federal requirements and remain eligibility to use federal funds, a project must be accurately documented. To document the conformity of an ITS project with the regional architecture, MDOT's ITS Program Office will oversee the development of a regional architecture conformance form to guide project managers through the process. The project managers will be able to coordinate with the ITS Program Office and regional contact for additional assistance and guidance. The steps of the process are as follows:

- Identify the ITS components in the project;
- Identify the corresponding market packages(s) from the Regional ITS Architecture;
- Locate the component within the market package;
- Compare the connections to other agencies or elements documented in the ITS architecture as well as the information flows between them to the connections that will be part of the project;
- Assess the use of relevant standards; and
- Document any changes necessary to the ITS Architecture or the project to ensure there is conformance.

Identifying the ITS Components

ITS components can be fairly apparent in an ITS focused project such as CCTV or DMS deployments, but could also be included in other types of projects. For example, an arterial widening project could include the installation of signal system interconnect, signal upgrades, and the incorporation of the signals in the project limits into the MDOT's signal system. These are all ITS deployments and should be part of the ITS architecture.

Identifying the Corresponding Market Packages

If a project was included in Table 10 of the Deployment Plan, then the applicable market package(s) for that project are identified in a column. ITS projects are not required to be included in the ITS Deployment Plan in order to be eligible for federal funding; therefore, market packages might need to be identified without the assistance of an ITS Deployment Plan. In that case, the market packages selected and customized for the Grand Region are identified in **Table 5** of this document, detailed market package definitions are located in **Appendix A**, and customized market packages for the Grand Region are included in **Appendix B**.

Identifying the Component within the Market Package

The customized market packages for the Grand Region are located in **Appendix B**. Once the element is located on the market package, the evaluator may determine that the element name should be modified. For example, an element called the Local Agency TOC was included in the architecture, but at the time of deployment, Muskegon will more than likely decide to call the center by a specific name. This name change should be documented using the process outlined in Section 1.3.

Evaluating the Connections and Flows

The connections and architecture flows documented in the market package diagrams were selected based on the information available at the time the plan was developed. As the projects are designed, decisions will be made on the system layout that might differ from what is shown in the market package. These changes in the project should be documented in the ITS market packages using the process outlined in Section 1.3.

Relevant Standards

ITS Standards are documented guidelines or rules specifying the interconnections among elements and the characteristics of technologies and products to be used in ITS installations. Standards describe in detail what types of interfaces should exist between ITS components and how the components will exchange information and work together to deliver certain user services. The Grand Regional ITS Architecture highlights the relevant standards based on the region's needs. These standards should be reviewed as part of this conformity exercise. Where standards can be utilized, they should be noted. Where standards are not or could not be utilized, an explanation of why, also should be noted.

Documenting Required Changes

If any changes are needed to accommodate the project under review, Section 1.3 describes how those changes should be documented. Any changes will be incorporated during the next architecture update. Conformance will be accomplished by documenting how the market package(s) should be modified so that the connections and data flows are consistent with the project.

5.2 Maintenance Process

MDOT's ITS Program Office will be responsible for leading the maintenance of the Grand Regional ITS Architecture and Deployment Plan in coordination with the regional contact. Maintenance includes modifications to the plan as well as complete updates. **Table 10** summarizes the maintenance process agreed upon by stakeholders in the Region.

Table 11 - Regional ITS Architecture and Deployment Plan Maintenance Summary

Maintenance Details	Regional ITS Architecture		Regional ITS Deployment Plan	
	Modification	**Complete Update**	**Modification**	**Complete Update**
Timeframe for Updates	As needed	Every 5-7 years	As needed	Every 5-7 years
Scope of Update	Update market packages to satisfy architecture conformance requirements of projects or to document other changes that impact the ITS Architecture	Entire ITS Architecture	Update project status and add or remove projects as needed	Entire ITS Deployment Plan
Lead Agency	MDOT ITS Program Office*		MDOT ITS Program Office*	
Participants	Stakeholders impacted by market package modifications	Entire stakeholder group	Entire stakeholder group	
Results	Market package or other change(s) documented for next complete update	Updated Grand Regional ITS Architecture document, Appendices, and Turbo Architecture database	Updated project tables	Updated Grand Regional ITS Deployment Plan document

** Transit related projects will be supported by MDOT's Bureau of Passenger Transportation*

Modifications to the Regional ITS Architecture and Deployment Plan will often be necessitated by ITS projects that are receiving federal funding but do not conform to the Regional ITS Architecture. MDOT's ITS Program Office will take the lead in working with agencies that receive federal funding for ITS projects and will keep a record of any changes that are needed to the Regional ITS Architecture. Complete updates to the Regional ITS Architecture will occur approximately every five to seven years and will be led by the MDOT's ITS Program Office with support from the MDOT Grand Region and other key stakeholders. The entire stakeholder group that was engaged to develop this first Regional ITS Architecture will be reconvened for the complete updates.

5.3 Procedure for Submitting ITS Architecture Changes Between Scheduled Updates

Updates to the Grand Regional ITS Architecture will occur on a regular basis as described in Section 1.2 to maintain the architecture as a useful planning tool. Between complete plan updates, smaller modifications will likely be required to accommodate ITS projects in the Region. Section 1.1 contains step by step guidance for determining whether or not a project requires architecture modifications.

For situations where a change is required, an ITS Architecture Maintenance Documentation Form was developed and is included in **Appendix E**. This form should be completed and submitted to the MDOT ITS Program Office whenever a change to the Regional ITS Architecture or

Deployment Plan is proposed. Please note that MDOT's Bureau of Passenger Transportation also should be copied if the project has a transit related component.

The Maintenance Documentation form identifies three levels of modifications. They include:

- Level 1 – Basic changes that do not affect the structure of the architecture.
  Examples include: Changes to stakeholder or element name, element status, or data flow status.
- Level 2 – Structural changes that impact only one agency.
  Examples include: Addition of a new market package or modifications to an existing market package that affects only one agency.
- Level 3 – Structural changes that have the potential to impact multiple agencies.
  Examples include: Addition of a new market package or modifications to an existing market package that involves multiple agencies or incorporation of a new stakeholder into the architecture.

While documenting the proposed change, the project manager completing the change form should coordinate with any of the other agencies that may be impacted by the modification. This communication between agencies will simplify the process of performing a complete plan update. MDOT's ITS Program Office will review and accept the proposed changes. When a complete update is performed by MDOT's ITS Program Office, all of the documented changes will be incorporated into the regional ITS architecture. **Figure 11** graphically illustrates this process.

Figure 11 - Process for Documenting Architecture Performance